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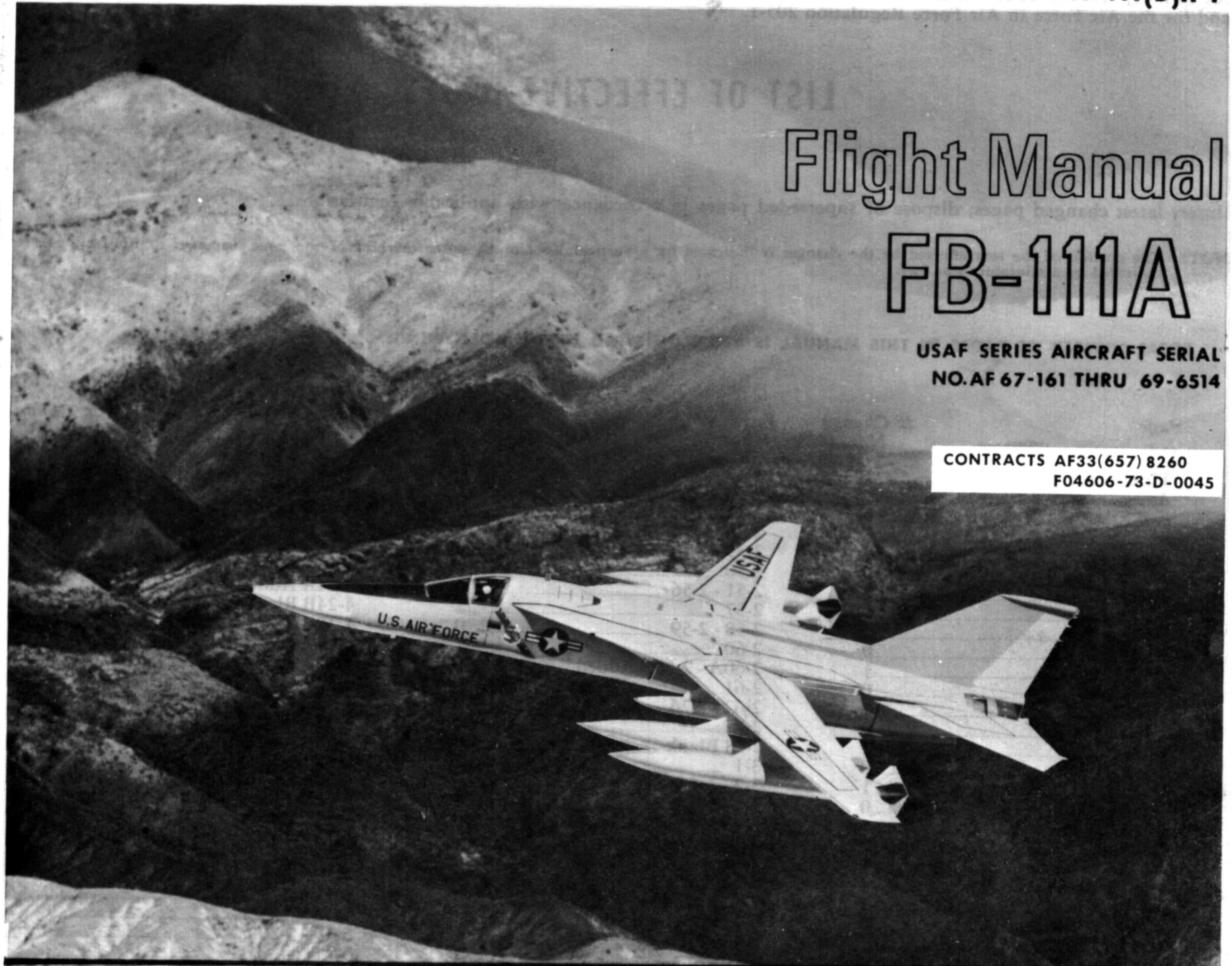

Flight Manual

FB-111A

USAF SERIES AIRCRAFT SERIAL NO. AF 67-161 THRU 69-6514

CONTRACTS AF33(657) 8260
F04606-73-D-0045

CHANGE NOTICE

LATEST CHANGED PAGES SUPERSEDE THE SAME PAGES OF PREVIOUS DATE

Insert changed pages into basic publication. Destroy superseded pages.

THIS PUBLICATION IS INCOMPLETE WITHOUT T.O. 1F-111(B)A-1-1 AND T.O. 1F-111(B)A-1-3

THIS PUBLICATION REPLACES SAFETY SUPPLEMENTS T.O. 1F-111(B)A-1SS-1, -6 AND -50 AND OPERATIONAL SUPPLEMENTS T.O. 1F-111(B)A-1S-2 THRU -5, -47 AND -48.

See Numerical Index and Requirement Table for Current Status of Safety and Operational Supplements

Commanders are responsible for bringing this publication to the attention of all Air Force personnel cleared for operation of subject aircraft.

PUBLISHED UNDER THE AUTHORITY OF THE SECRETARY OF THE AIR FORCE

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1 JUNE 1973

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AIR FORCE 11 Dec 73-1400

LIST OF EFFECTIVE PAGES

Insert latest changed pages; dispose of superseded pages in accordance with applicable regulations.

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CURRENT
FLIGHT CREW CHECKLIST
1F-111(B)A-1CL-1
12 OCTOBER 1973

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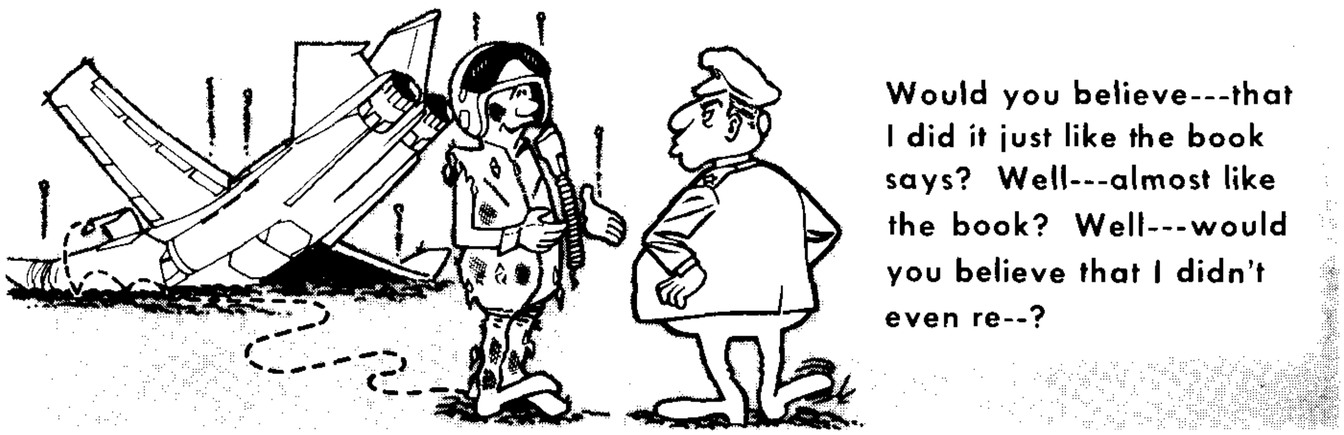

SCOPE.

This manual contains the necessary information for safe and efficient operation of the aircraft. These instructions provide you with a general knowledge of the aircraft, its characteristics, and specific normal and emergency operating procedures. Your experience is recognized, and therefore, basic flight principles are avoided. Instructions in this manual are for a crew inexperienced in the operation of this aircraft. This manual provides the best possible operating instructions under most circumstances. Multiple emergencies, adverse weather, terrain, etc., may require modification of the procedures.

PERMISSIBLE OPERATIONS.

The Flight Manual takes a "positive approach" and normally states only what you can do. Unusual operations or configurations are prohibited unless specifically covered herein. Clearance must be obtained before any questionable operation not specifically permitted in this manual is attempted.

HOW TO BE ASSURED OF HAVING LATEST DATA.

Refer to the Flight Manual and Supplement Status page (flyleaf) published with each Safety and Operational Supplement for a comprehensive listing of the current Flight Manuals, Flight Crew Checklists, Safety Supplements and Operational Supplements. T.O. 0-1-1-4 should be checked periodically to make sure you have current Flight Manuals, Checklists and Supplements.

ARRANGEMENT.

The manual is divided into seven fairly independent sections to simplify reading it straight through or using it as a reference manual.

Note

Performance data normally included in Appendix I is contained in T.O. 1F-111(B)A-1-1.

SAFETY SUPPLEMENTS.

Information involving safety will be promptly forwarded to you by Safety Supplement. Supplements covering loss of life will get to you within 48 hours by TWX, and those covering serious damage to equipment within 10 days by mail. The title page of the Flight Manual and the title block of each Safety Supplement should be checked to determine the effect they may have on existing Supplements. You must remain constantly aware of the status of all Supplements. Current Supplements must be complied with, but there is no point in restricting your operation by complying with a replaced or rescinded Supplement.

OPERATIONAL SUPPLEMENTS.

Information involving changes to operating procedures will be forwarded to you by Operational Supplements. The procedure for handling Operational Supplements is the same as for Safety Supplements.

CHECKLISTS.

The Flight Manual contains only amplified procedures. Abbreviated Checklists are issued as separate documents; see the back of the title page for the date of your latest Checklist. Line items in the Flight Manual and Checklists are identical with respect to arrangement and step number. Whenever a Safety Supplement affects the Checklist, write in the applicable change on the affected Checklist page. As soon as possible, a

new Checklist page incorporating the Supplement will be issued. This will keep handwritten entries of Safety Supplement information in your Checklist to a minimum.

HOW TO GET PERSONAL COPIES.

Each flight crew member is entitled to personal copies of the Flight Manual, Safety Supplements, Operational Supplements, and Checklists. The required quantities should be ordered before you need them to assure their prompt receipt. Check with your supply personnel — it is their job to fulfill your Technical Order requests. Basically, you must order the required quantities on the appropriate Numerical Index and Requirement Table (NIRT). T.O. 00-5-1 and T.O. 00-5-2 give detailed information for properly ordering these publications. Make sure a system is established at your base to deliver these publications to the flight crews immediately upon receipt.

FLIGHT MANUAL BINDERS.

Looseleaf binders and sectionalized tabs are available for use with your manual. These are obtained through local purchase procedures and are listed in the Federal Supply Schedule (FSC Group 75, Office Supplies, Part 1). Check with your supply personnel for assistance in procuring these items.

WARNINGS, CAUTIONS, AND NOTES.

The following definitions apply to "Warnings", "Cautions", and "Notes" found throughout the manual.

WARNING

Operating procedures, techniques, etc., which will result in personal injury or loss of life if not carefully followed.

CAUTION

Operating procedures, techniques, etc., which will result in damage to equipment if not carefully followed.

Note

An operating procedure, technique, etc., which is considered essential to emphasize.

YOUR RESPONSIBILITY — TO LET US KNOW.

Every effort is made to keep the Flight Manual current. Review conferences with operating personnel and a constant review of accident and flight test reports assure inclusion of the latest data in the manual. However, we cannot correct an error unless we know it exists. In this regard, it is essential that you do your part. Comments, corrections, and questions regarding this manual or any phase of the Flight Manual program are welcomed. These should be forwarded on Form 847 through your Command Headquarters to:

SMAMA
McClellan AFB, California 95652
Attn: MMSTA

AIRCRAFT DESIGNATION CODES.

Major differences between aircraft covered in this manual are designated by number symbols which appear in the text or on illustrations. Symbol designations for individual aircraft and groups of aircraft are as follows:

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▶ "through" or "and on".

GLOSSARY

A/B	Afterburner
ADI	Attitude Director Indicator
AFRS	Auxiliary Flight Reference System
AILA	Airborne Instrument Low Approach
AIPD	Airborne Intercept Pulse Doppler
AIR FF	Air Freefall
AIR RET	Air Retard
ALT CAL	Altitude Calibration
ALT HLD	Altitude Hold
ALTM	Altimeter
AMAC	Aircraft Monitor and Control
AME	Amplitude Modulation Equivalent
AMI	Airspeed-Mach Indicator
ANT	Antenna
ASTM	American Society for Testing Materials
ATF	Automatic Terrain Following
ATT	Attitude
AVVI	Altitude-Vertical Velocity Indicator
AYC	Adverse Yaw Compensation
BCN	Beacon
BDHI	Bearing Distance Heading Indicator
BNDTI	Bomb Nav Distance Time Indicator
CADC	Central Air Data Computer
CCM	Counter-Counter Measures
CCU	Computer Control Unit
C/D	Climb/Dive
CDS	Control and Display Set
CIR	Circular
CKT	Circuit
CMD	Command
CMDS	Countermeasures Dispenser Set
COM	Common
COMP	Compass
CRS LINE	Course Line
CRS SEL NAV	Course Select Navigation
CSD	Constant-Speed Drive
CS	Converter Set
CSS	Coded Switch Set
CSSC	Coded Switch Set Controller
CTR	Constant Track Release
DCC	Digital Computer Complex
DEST	Destination
DG	Directional Gyro
DISP	Dispenser
DIV	Dive
EBL	Emergency Boom Latching
EPI	Elevator Position Indicator
EPR	Engine Pressure Ratio
EVF	Enter Visual Fix
FDC	Flight Director Computer
FLSC	Flexible Linear Shaped Charges
FSK	Frequency Shift Keying
FTC	Fast Time Constant
FXPT	Fixpoint
G/C	Gyrocompass
GM	Ground Mapping
GNC	General Navigation Computer
HOM	Homing
HSD	Horizontal Situation Display
HSI	Horizontal Situation Indicator
ICU	Indicator Control Unit
IFIS	Integrated Flight Instrument System
INS	Inertial Navigation Set
IRT	Infrared Track
IRS	Infrared Search
IRRS	Infrared Receiver System
IRU	Inertial Reference Unit
ISC	Instrument System Coupler
LADD	Low Angle Drogue Delivery
LNCH	Launch
LSB	Lower Side Band
MFC	Manual Frequency Control
MR	Milliradian
MRT	Modulator-Receiver Transmitter
MSMA	Maximum Safe Mach Assembly
NDU	Navigation Display Unit
NTIK	Non-Tactical Instrumentation Kit
NWS/AR	Nose Wheel Steering/Air Refueling
ODS	Optical Display Sight
OMO	Omni Warning Open
OMS	Off, Monitor, Safe
OMT	Omni Warning Threat
OTL	Operational Test Launch
PCSS	Pitch Control Stick Steering
PP, PRES/POS	Present Position
PPI	Plan Position Indicator
RAD	Radiation
RCSS	Roll Control Stick Steering
RHAWS	Radar Homing and Warning System
SAF	Safe, Arm and Fuze
SIT	Situation Display
SLC	Side Lobe Cancellation
SMDC	Shielded Mild Detonating Cord

SPC	Special Purpose Chaff
SPU	Systems Program Unit
SRAM	Short Range Attack Missile
STAB AUG	Stability Augmentation
STC	Sensitivity Time Control
TAL	Transfer Alignment Procedure
TBC	Trackbreaker Chaff
TDU	Threat Display Unit
TED	Trailing Edge Down
TEU	Trailing Edge Up
TFR	Terrain Following Radar
TG (Tg)	Time-to-Go
TIT	Turbine Inlet Temperature
TKR RV	Tanker Rendezvous
TTI	Total Temperature Indicator
USB	Upper Sideband
WDC	Weapons Delivery Computer

DEFINITIONS.

ASYMMETRICAL LOADING

Weapon/tank load on any pylon is not identical to the corresponding pylon on opposite wing

SYMMETRIC MANEUVER

A pull-out or push-over maneuver or steady bank

ASYMMETRIC MANEUVER

A rolling pull-out

HERTZ (Hz)

A new term for cycles per second (cps) when used in conjunction with electrical or electronic language.

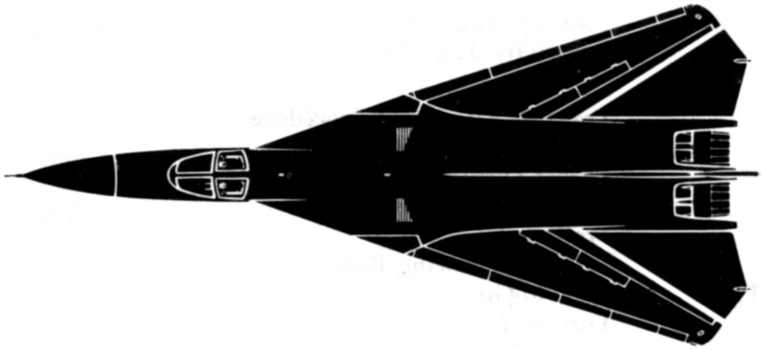
LIMIT CYCLE

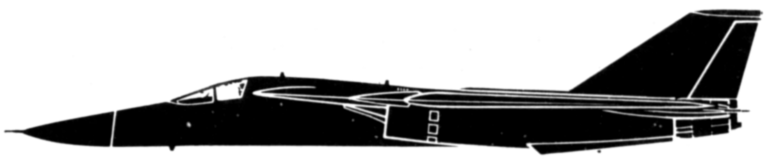
A sustained oscillation which builds up to and maintains a constant amplitude.

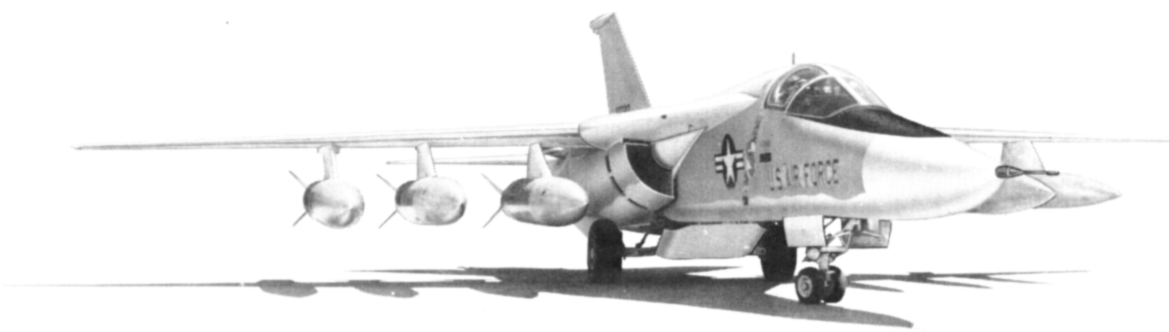
THE

FB-111A

AIRPLANE







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AIRCRAFT RETROFIT TECHNICAL ORDER INFORMATION

This list includes the applicable TCTO numbers that have been issued up to the date of this publication. Those issued after that date will appear in the next Change/Revision. This is not a complete TCTO listing. Refer to the Basic Index (T.O. 0-1-1-4) for the complete listing of TCTO's which are applicable to this aircraft. Throughout this manual, the terms "Prior to T.O. —" and "After T.O. —" refer to aircraft prior to modificaton and aircraft after modification, respectively.

T.O. No.	*Short Title*	*System/Equipment Affected*
1F-111-505	Provide Overboard Water Drain for ECS	Air Conditioning & Pressurization System, Section I.
1F-111-563	AN/APS-109/ALR-41 RHAWS	Penetration Aids, Section I, T.O. 1F-111(B)A-1-3.
1F-111-571	Relocate Rudder Authority Hydraulic Line	Hydraulic System, Section I.
1F-111-583	Install Hydraulic Fuse	Hydraulic System, Section I.
1F-111-599	Modify Hydraulic Isolation Circuit	Hydraulic System, Section I.
1F-111-611	Fire Detection System Ground Test Switches	Engines, Section I.
1F-111-677	Add New Ground Interphone Receptacle	Communications Equipment, Section I
1F-111-742	Add Divider Between Wheel Well and Wing Cavity	Speed Brake Limits, Section V.
1F-111-755	Install New Autopilot/Damper Switches	Autopilot System, Section I.
1F-111-760	Add Strap to Restraint Harness	Crew Module, Section I
1F-111-779	Replace TFR Knobs—Easier Identification	TFR, Section I.
1F-111-780	Relocate Attack Radar Scope Controls	Attack Radar, Section I.
1F-111-819	RHAWS (AN/APS-109A/ALR-41)	Penetration Aids, T.O. 1F-111(B)A-1-3.
1F-111-824	Add New Full Flap Stop	Wing Flaps and Slats, Section I.
1F-111-829	Deactivate LSTC	Flight Control System, Sections I and VI.
1F-111-833	Install Improved CMRS (AN/AAR-34)	Penetration Aids, T.O. 1F-111(B)A-1-3.
1F-111-863	Install AN/ARC-123 HF Radio	Communications Equipment, Section I.
1F-111-876	Modify Fuel Pylons	Stores Limitations, Section V.

T.O. No.	*Short Title*	*System/Equipment Affected*
1F-111-877	Current Limiting Device for IRU	Cold Weather Procedures, Section VII
1F-111-891	New Stall Warning System	Flight Controls, Section I.
1F-111-946	Weapons Bay Overheat Detection	Wheel Well Overheat Detection System, Section I
1F-111-996	Incorporate Improvements in TFR/ LARA Systems	TFR & LARA, Section I
1F-111-1020	Replace Inboard Spoiler Inboard Link Drive Assembly	Maneuverability Limitations, Section V
1F-111-1074	Improve Detectability of RHAWS Audio Signals and Warning Tone	Communications Equipment and TFR, Section I
1F-111(B)A-521	Bombing Timer	Armament, Section I.
1F-111(B)A-554	Install Secondary Pitot Static System	Pitot Static System, Section I.
1F-111(B)A-567	Nav/LCOS Tie-in RHAW	Penetration Aids, T.O. 1F-111(B)A-1-3.
1F-111(B)A-589 and -590	Modify Fuel Pylons	Stores Limitations, Section V.
1F-111(B)A-593	Modify Yaw and Roll Flight Control Computers, Feel and Trim Assy, and Control Stick	Autopilot System, Section I
1F-111(B)A-602	Add ECM Set (AN/ALQ-94)	Penetration Aids, T.O. 1F-111(B)A-1-3.
1F-111(B)A-620	Modify Bomb Release Program Unit	Safe Jettison, Section III.
1F-111(B)A-637	Install Attitude Monitor System	Instruments, Section I Caution Lamp Analysis, Section III
1F-111(B)A-650	Deactivation of Hydraulic Pump Depressurizing Valves	Hydraulic System, Section I
1F-111(B)A-651	Modify Flight Program for Bomb Nav and TFR Systems	TFR, Section I

SECTION I

DESCRIPTION & OPERATION

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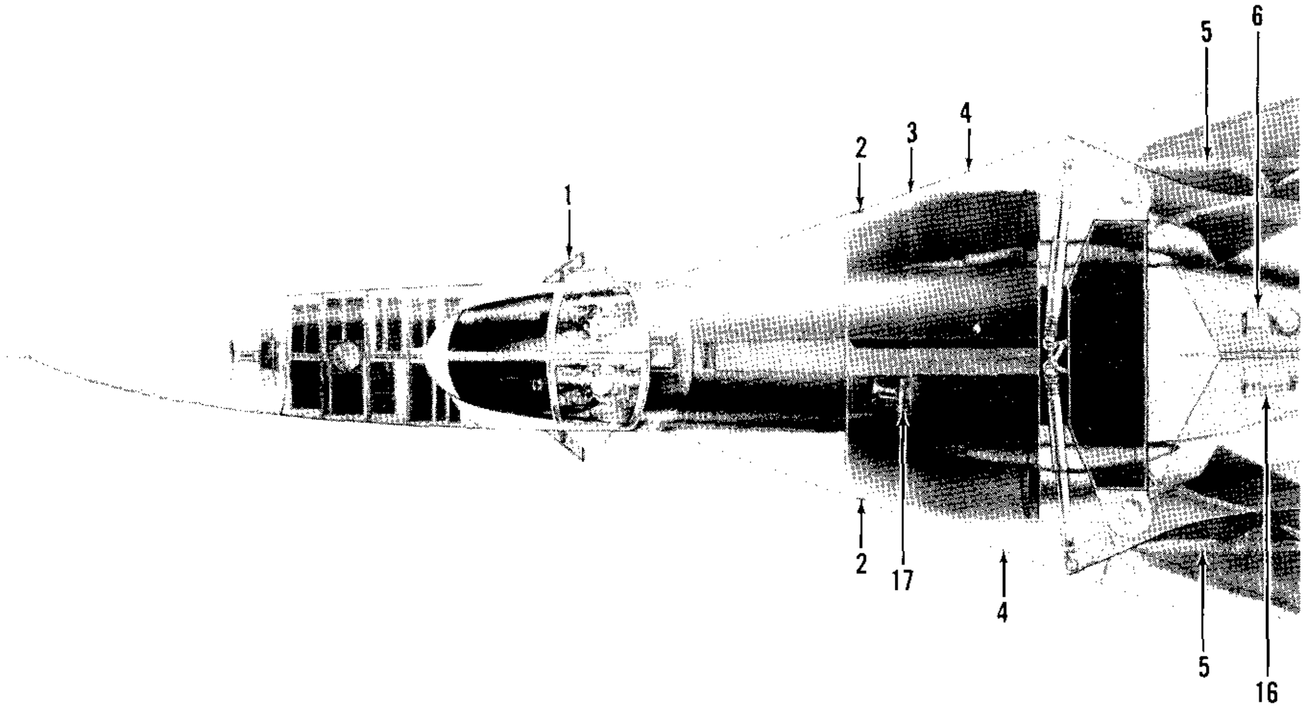
THE AIRCRAFT.

The FB-111A is a two-place (side-by-side) long-range fighter bomber built by General Dynamics, Convair Aerospace Division, Fort Worth Operation. The aircraft is designed for all weather supersonic operation at both low and high altitudes. Mission capabilities include long range attack missions utilizing conventional or nuclear weapons. An automatic low altitude terrain following system enhances penetration capability. Power is provided by two TF-30 axial-flow, dual-compressor turbofan engines equipped with afterburners. The wings, equipped with leading edge slats and trailing edge flaps, may be varied in sweep, area, camber, and aspect ratio by the selection of any wing sweep angle between 16 and 72.5 degrees. A selective forward wing sweep provides takeoff and landing capabilities at minimum speeds. For all other regimes, the wings are manually swept in accordance with desired mach number. This feature provides the aircraft with a highly versatile operating envelope. The empennage consists of a fixed vertical stabilizer with rudder for directional control and a horizontal stabilizer that is moved symmetrically for pitch control and asymmetrically for roll control. Stability augmentation incorporates triple redundant features which enhance system reliability. The tricycle-type forward retracting landing gear is hydraulically operated. The main landing gear consists of a single common trunnion upon which two wheels are singly mounted and contains but one extending/retracting/locking system, which ensures symmetrical main gear operation. Also, ground loads imposed upon the gear tend to extend the drag strut to the locked position. Stores are carried in a fuselage-enclosed weapons bay and externally on both pivoting and fixed wing-mounted pylons. The fuel system incorporates both inflight and single point ground refueling capabilities. See figure 1-1 aircraft general arrangement.

AIRCRAFT DIMENSIONS.

Length (overall including pitot-static boom) — 75 feet, 6.5 inches
Wing span (wings swept) — 34 feet
Wing span (wings extended) — 70 feet

General Arrangement Diagram



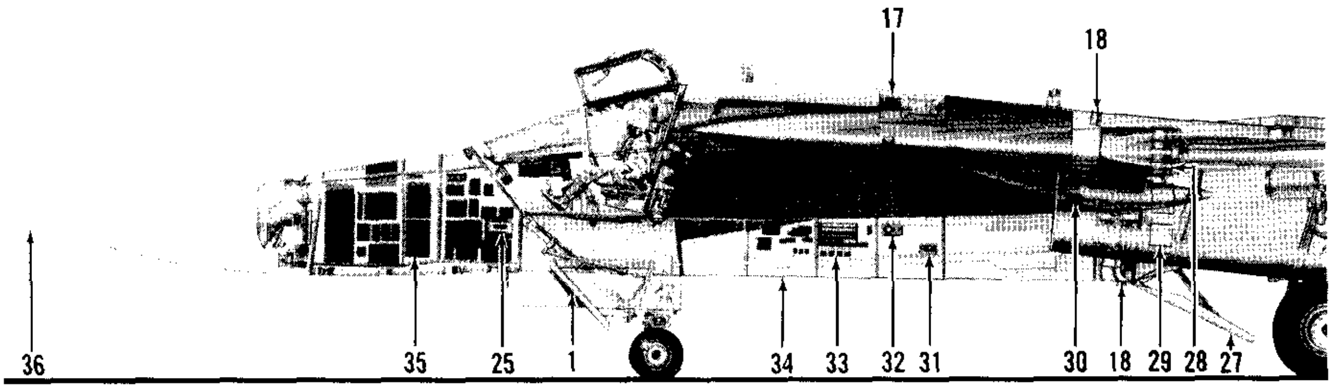


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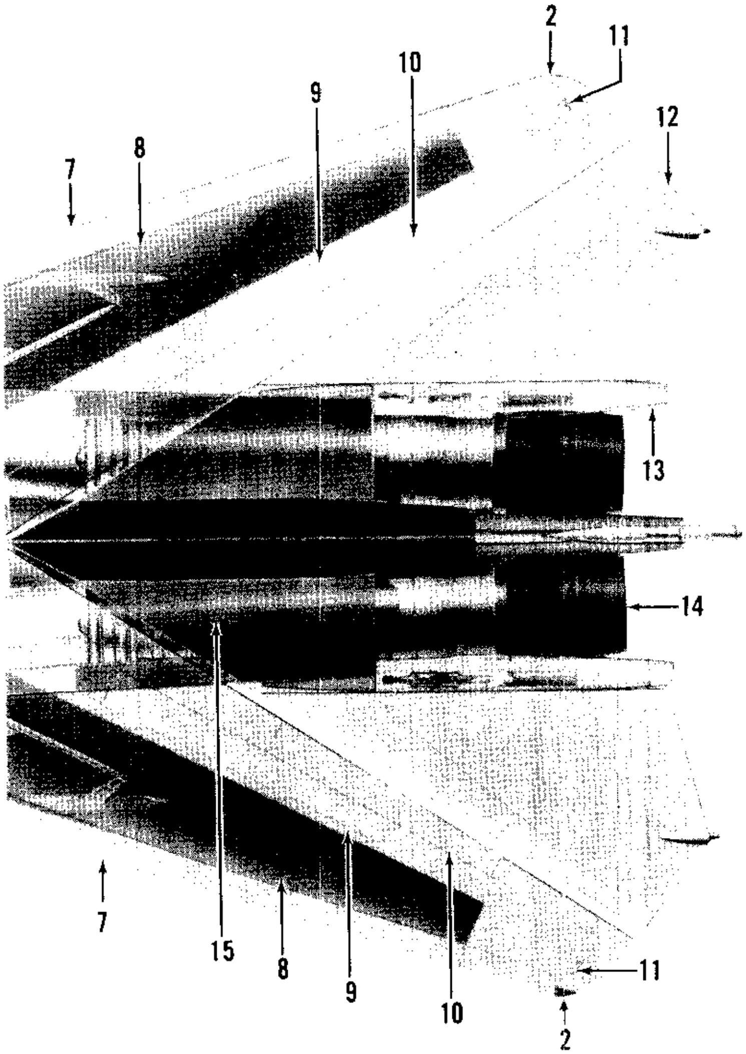
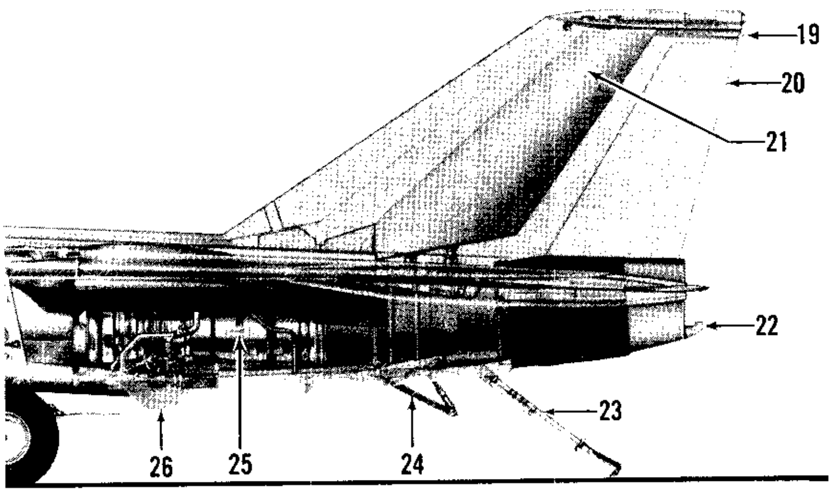
Figure 1-1. (Sheet 1)





1. Entrance Ladder and Step.
2. Wing Position Lights.
3. Forward Fuel Tanks.
4. Rotating Glove.
5. Pivoting Pylons.
6. Primary Hydraulic System Reservoir.
7. Slats.
8. Wing Fuel Tanks.
9. Spoilers.
10. Wing Flaps.
11. Wing Formation Lights (Upr & Lwr).
12. Horizontal Stabilizer.
13. Speed Bumps.
14. Engines.
15. Aft Fuel Tank.
16. Utility Hydraulic System Reservoir.
17. Air Refueling Receptacle.
18. Anti-Collision Lights (Upper & Lower).
19. Tail Position Light.
20. Rudder.
21. Fuel Vent Tank.
22. Fuel Dump Outlet.
23. Arresting Hook.
24. Tail Bumper.
25. Fuselage Formation Lights (4).
26. Strake (2).
27. Forward Landing Gear Door/Speed Brake.
28. Air Conditioning System Cooling Air Intake.
29. Blow-In Doors.
30. Spike.
31. Fuel System Precheck Selector Panel.
32. Single Point Refueling Adapter Receptacle.
33. Aft Electronic Equipment Bay.
34. Weapons Bay.
35. Forward Electronic Equipment Bay.
36. Pitot Static Probe.

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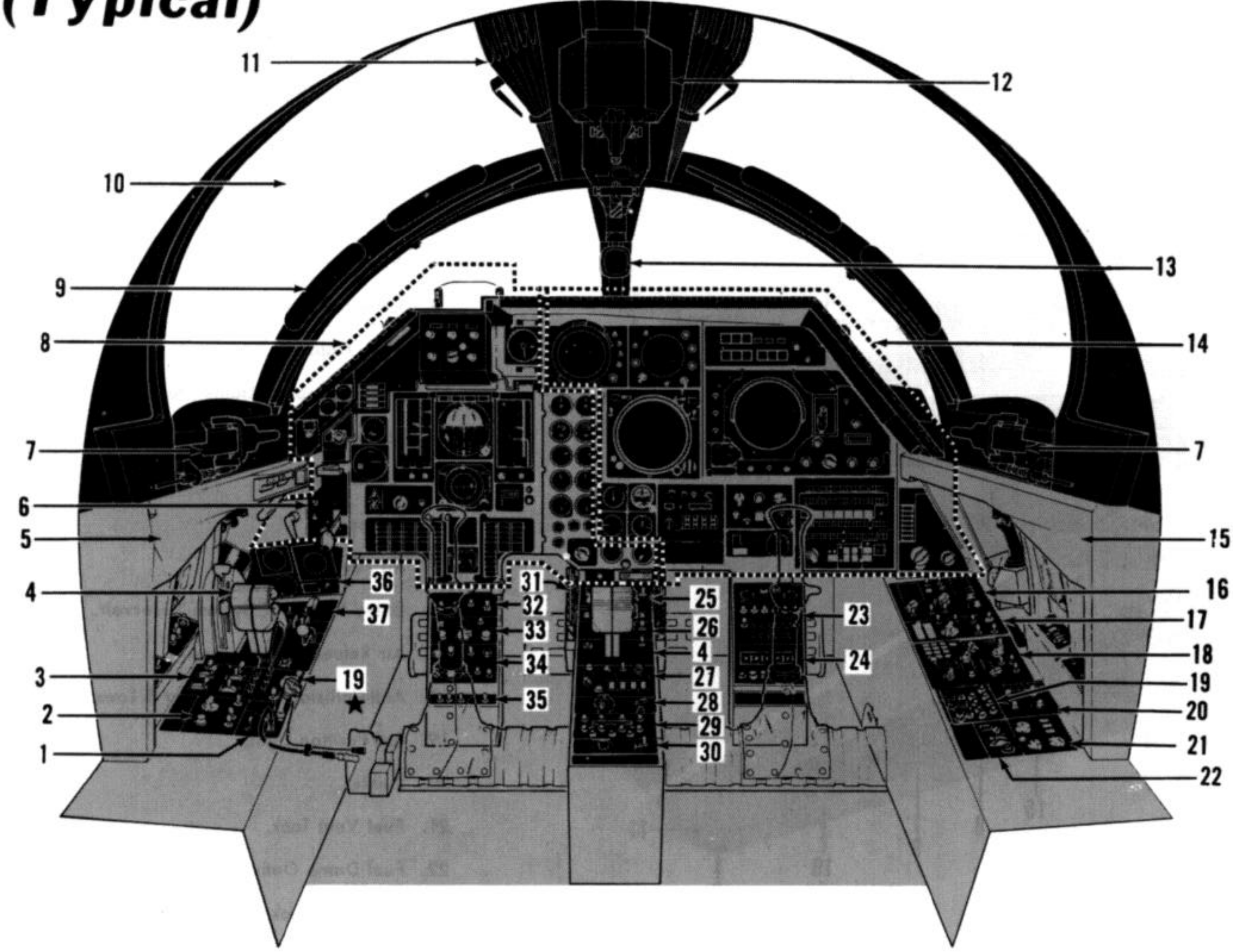
Figure 1-1. (Sheet 2)

Crew Station General Arrangement (Typical)



1. Left Station Oxygen Control Panel (See Fig. 1-76).
2. Air Conditioning Control Panel (See Fig. 1-70).
3. Autopilot Damper Panel (See Fig. 1-26).
4. Throttle Panels (See Fig. 1-5).
5. Left Sidewall (See Fig. 1-25).
6. Landing Gear Control Panel (See Fig. 1-16).
7. Internal Canopy Latch Handle (2).
8. Left Main Instrument Panel (See Fig. 1-6).
9. Mirrors (4).
10. Canopy Hatches (2).
11. Thermal Curtains (2).
12. Canopy Center Beam Assembly (See Fig. 1-77).
13. Magnetic Compass.
14. Right Main Instrument Panel (See Fig. 1-31).
15. Right Sidewall (See Fig. 1-72).
16. Stores Control Panel (See Fig. 1-49).
17. SRAM Control Panel. (See Fig. 1-50)
18. Computer Control Panel (See Fig. 1-48).
19. Communications Panel (See Fig. 1-40)

*20. CMDS Control Panel.
*21. AN/ALQ-94 ECM Control Panel.
*22. ECM Destruct Control Panel.
23. IFF Control Panel (See Fig. 1-44).
**24. Coded Switch Set Controller Panel.
25. Fuel Control Panel (See Fig. 1-9).
26. TFR Control Panel (See Fig. 1-63).
27. UHF Radio Control Panel (See Fig. 1-38).
28. TACAN Control Panel (See Fig. 1-42).
29. HF Radio Control Panel (See Fig. 1-39).
30. ILS Control Panel (See Fig. 1-43).
31. Ejection Handles (2).
32. Windshield Wash/Anti-Icing Control Panel (See Fig. 1-73)
33. Compass Control Panel (See Fig. 1-28).
34. Electrical Control Panel (See Fig. 1-11).
35. Antenna Select Panel (See Fig. 1-45).
36. Auxiliary Gage Panel (See Fig. 1-15).
37. Miscellaneous Switch Panel (See Fig. 1-60)

*See T.O. 1F-111(B)A-1-3.
**See Applicable Weapons Delivery Manual.

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Figure 1-2. (Sheet 1)

38. Mission Data Box (2).
39. Relief Container (2).
40. Drinking Cups (2).
41. Weight and Balance T.O. and Flight Record Stowage.
42. Food and Liquid Stowage (2).
43. Air Diffusers (2).
44. Spare Bulb Stowage.
45. Hood Stowage.
46. Letdown Chart Stowage.
47. Internal Lighting Fuse Panel.
48. Lighting Control Panel (See Fig. 1-66).
49. Cabin Air Distribution Control Lever.
50. Utility Light.
51. Quick Rescue Kit.
52. Letdown Chart Holder Stowage.
53. Safety Pin Stowage.
54. Circuit Breaker Panel (See Fig. 1-13).
55. Ground Check Panel (See Fig. 1-27).
56. Flight Manual Stowage.
57. Arrival and Inflight IFR Chart Stowage.
58. Right Station Oxygen Control Panel (See Fig. 1-73).

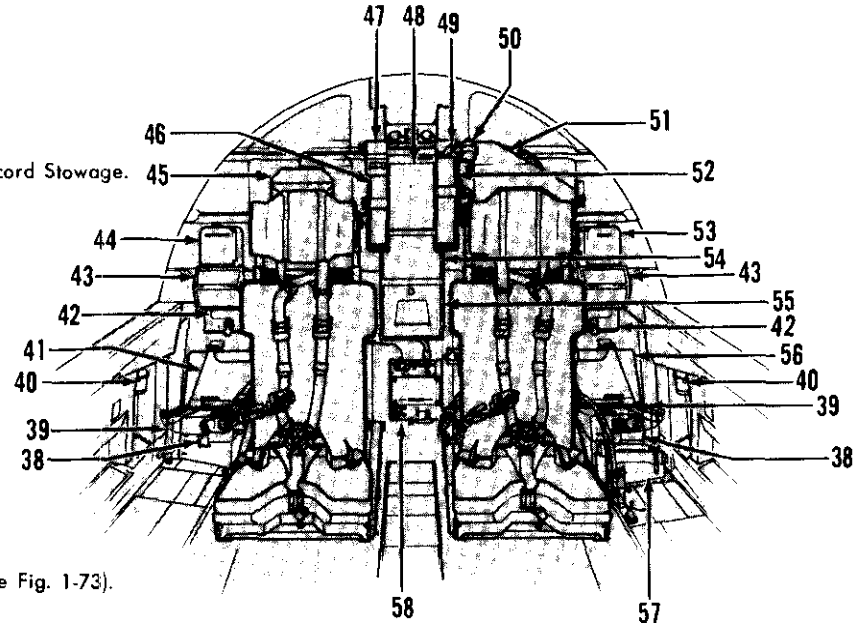


Figure 1-2. (Sheet 2)

Height (to top of vertical tail) — 17 feet, 5 inches

Refer to Section II for turning radius dimensions.

AIRCRAFT WEIGHT.

The aircraft operating weight is in the 49,000 pound class. The maximum gross weight varies with weapon configuration. For information regarding gross weights for various weapon configurations refer to Center-of-Gravity Envelope, Section VI. For specific aircraft weight, refer to the associated handbook of Weight and Balance Data, T.O. 1-1B-40.

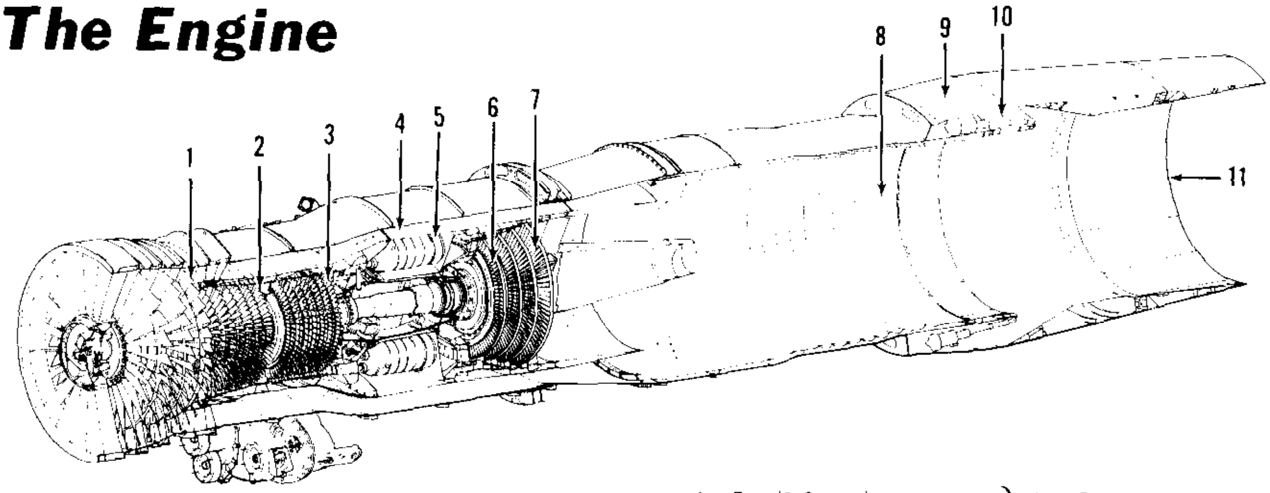
FLIGHT CREW.

The flight crew consists of a pilot and navigator seated side-by-side. The crew member assigned to the left crew station serves as pilot. The crew member assigned to the right crew station serves as navigator and operates the offensive and defensive equipment associated with the controls at that station.

ENGINES.

The aircraft is powered by two Pratt and Whitney TF-30, sixteen-stage axial flow turbo-fan engines equipped with afterburners. See figure 1-3. The engines are mounted side by side in the fuselage and are interchangeable. The sea level, standard day uninstalled thrust rating of the engine is in the 12,000 pound class in military power and in the 20,000 pound class in afterburner. Provisions are made for starting the engines with an external pneumatic ground starter cart. Also, the left engine has the capability of being started without the aid of ground support equipment by means of a pyrotechnic cartridge. With either engine operating, the other engine can be started by using bleed air from the operating engine. Electrical power is supplied for the engine igniter plugs by an engine-driven alternator. Each engine is supplied a flow of air through a separate inlet duct located below the intersection of the wing and the fuselage. An automatically controlled, movable spike is used in each inlet duct to control airflow to the engines. The engine air inlets are equipped with free floating blow-in doors which allow additional air to the engine as it is required. Splitter vanes are used at the front of the inlet ducts to remove the low energy air from the fuselage and the lower surface of the wing glove, thus preventing boundary layer air from disturbing engine inlet air. These features allow optimum engine performance throughout a wide range of aircraft operating conditions. Air from the inlet of each engine is routed

The Engine



1. Fan (3 Stages).
2. N1 Compressor (6 Stages). } Low Pressure Compressor
3. N2 Compressor (7 Stages).
4. Fan Duct.
5. Combustion Chambers (8).
6. N2 Compressor Turbine (Single Stage).
7. Fan and N1 Compressor Turbine (3 Stages).
8. Afterburner Section.
9. Free Floating Blow-in Doors.
10. Variable Nozzle.
11. Tail Feathers.

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Figure 1-3.

through a single duct for both the basic engine section and the fan section. Three compressor stages provide initial pressurization of the air flowing into the engine and into the fan duct. The fan duct is a full annular duct which directs flow aft to join the engine airflow coming from the turbine discharge. The fan air develops a significant portion of total engine thrust. Engine air is compressed by 9 stages of the low pressure compressor (N1), of which three stages are the fan, and 7 stages of the high pressure compressor (N2). The air is then diffused into the combustion section, which contains 8 combustion chambers. The turbine section of the engine consists of a single-stage turbine to drive the high pressure compressor and a three-stage turbine to drive the low pressure compressor. The turbines are mechanically independent of each other. High pressure compressor speed is indicated by a tachometer. Speed of the low pressure compressor is not monitored except by an overspeed caution lamp. After leaving the turbine section of the engine, the air is joined with the fan air in the afterburner section. Bleed air from the engine compressors is used for cockpit and equipment bay air conditioning and pressurization, hydraulic system pressurization, fuel tank pressurization, hydraulic oil cooling, engine vortex destroyers, generator/CSD cooling, ground oil cooling, and windshield rain removal. Also, hot bleed air is used for engine inlet and guide vane anti-icing. (Refer to "Anti-Icing and Defog Systems", this section.) Compressor bleed valves are installed on the engines to bleed air from the compressor during operation in certain flight regimes as an aid in the prevention of compressor stalls. The valves are controlled to automatically open at mach 1.75 (± 0.10) and above.

ENGINE FUEL CONTROL SYSTEM.

Each engine fuel control system (figure 1-4) automatically provides optimum fuel flow for any throttle setting. This system responds to several engine operating parameters and makes it unnecessary to adjust the throttle in order to compensate for variations in inlet air temperature, altitude, or airspeed. The engine fuel system consists of a two-stage engine-driven fuel pump, fuel control unit, flowmeter, filter, pressurizing and dump valve, nozzles, and a fuel-oil heat exchanger. Fuel from the tanks is routed through the flowmeter to the centrifugal stage of the engine fuel pump, through a filter, and back to the gear stage of the pump. Bypass valves route fuel past the filter or first pump stage in event of failure of these components. The second pump stage delivers fully pressurized fuel to the fuel control unit, which provides metered fuel flow through the fuel-oil heat exchanger to the fuel pressurizing and

dump valve. This dual-function valve directs the fuel through the primary and secondary fuel manifolds to fuel nozzles which spray the fuel into the eight engine combustion chambers. When the fuel pressure drops during engine shutdown, the fuel pressurizing and dump valve automatically opens and drains the primary fuel manifold.

Fuel Control Unit.

The engine fuel control unit is a hydromechanical device incorporating an engine-driven, flyball-type speed governor. The control unit consists of a fuel metering system and a computing system which operates as a function of throttle setting, main combustion chamber pressure, high pressure rotor N2 speed, compressor inlet pressure, compressor inlet temperature, and flight mach number which is provided from the CADC.

Note

> Malfunctions of the CADC are normally indicated by the CADC caution lamp. However, failures can occur which result in incorrect mach data from the CADC to the fuel control unit without an accompanying CADC caution lamp. The effect of a CADC mach failure on the fuel control unit can occur only when the landing gear handle is in the UP position and will manifest itself with a sudden reduction in engine thrust. This malfunction will also result in an abnormally high mach indication on the AMI.

The metering system selects the rate of fuel flow to be supplied to the engine in response to the throttle setting. However, metering sections are regulated by the fuel control computing system which monitors the various engine operating parameters. Fuel enters the fuel control through a filter provided with a spring-loaded bypass. Fuel metering is accomplished by maintaining a constant pressure across a variable valve area which is controlled by the computing system. The constant pressure is maintained by use of a pressure-regulating bypass valve. This valve consists of a servo-operated valve and a spring-loaded valve. Normally, the servo maintains constant valve regulation, but in the event of servo malfunction, the spring valve alone will provide adequate regulation. Deviations from the desired metering pressure are sensed in the valve regulating unit which varies the bypass flow area, thereby restoring the desired pressure by returning excess fuel to the pump inlet.

ENGINE AFTERBURNERS.

The afterburner (AB) augments engine thrust by injecting fuel into the engine exhaust stream in the afterburner section, where it is ignited by a hot streak ignition system. Operation is controlled by the throttle. When the throttle is moved forward within the afterburner range, the afterburner fuel control pressurizes the afterburner first fuel manifold, (zone 1) schedules light-off flow, and activates the variable nozzle system. This system senses a pressure change and controls the exit area of the afterburner exhaust nozzle. Six blow-in doors are located near the aft end of the afterburner. These doors open any time outside air pressure is greater than pressure inside the duct, allowing outside air to enter and thus increasing the total engine thrust. The trailing edge of the afterburner consists of free-floating leaves which reduce drag at the aft end of the engine by directing the exhaust gases into the slipstream with minimum turbulence.

Afterburner Fuel System.

The afterburner fuel system (figure 1-4) consists of the following major components: an exhaust nozzle pump, an afterburner fuel pump, an afterburner fuel control unit with integral exhaust nozzle control, and fuel spray rings. Fuel from the tanks flows through the flowmeter to the afterburner fuel pump. The exhaust nozzle pump is supplied fuel from the boost stage of the engine main fuel pump. The exhaust nozzle pump supplies fuel to the afterburner fuel control until a predetermined fuel flow rate is exceeded. At this flow rate, the afterburner fuel pump inlet is opened and begins to supply fuel to the afterburner fuel control unit. Fuel from the afterburner pump passes through a fuel-oil cooler before entering the afterburner fuel control unit. This unit includes a computer and a high pressure flow section. Fuel is then directed to the spray rings, where it is atomized and ignited in the afterburner combustion chamber. Five zones of afterburning can be selected through the afterburner fuel control unit, which schedules fuel to the spray rings in the various zones of the afterburner as a function of throttle setting. When the throttle is advanced for afterburner initiation and when high pressure compressor speed exceeds approximately 83 percent rpm, the afterburner initiation valve schedules light-off fuel flow until afterburner light-off occurs, as sensed by the exhaust nozzle control.

Afterburner Ignition.

The function of the afterburner ignition system is to provide a means of igniting fuel in the afterburner to initiate afterburner operation. With the advancement of the throttle into AB, the afterburner igniter valve releases an auxiliary squirt of fuel which is injected just aft of the fourth stage turbine; then zone 1 fuel flow begins. After zone 1 flow begins, initial afterburner ignition is provided by a hot streak ignition system. The igniter valve injects a slug (main squirt) of fuel into number 4 combustion chamber creating a local overrich mixture. This fuel is ignited by the combustion chamber fire and the rich mixture results in a longer flame that burns past the turbines to provide hot streak ignition for the auxiliary squirt, which in turn ignites zone 1. Completion of the main squirt into number 4 combustion chamber provides a signal for cessation of the auxiliary squirt. If afterburner operation is not achieved, the throttle must be retarded to MIL or below and readvanced into AB to repeat the above series of events required for afterburner ignition.

Engine Fuel Control System

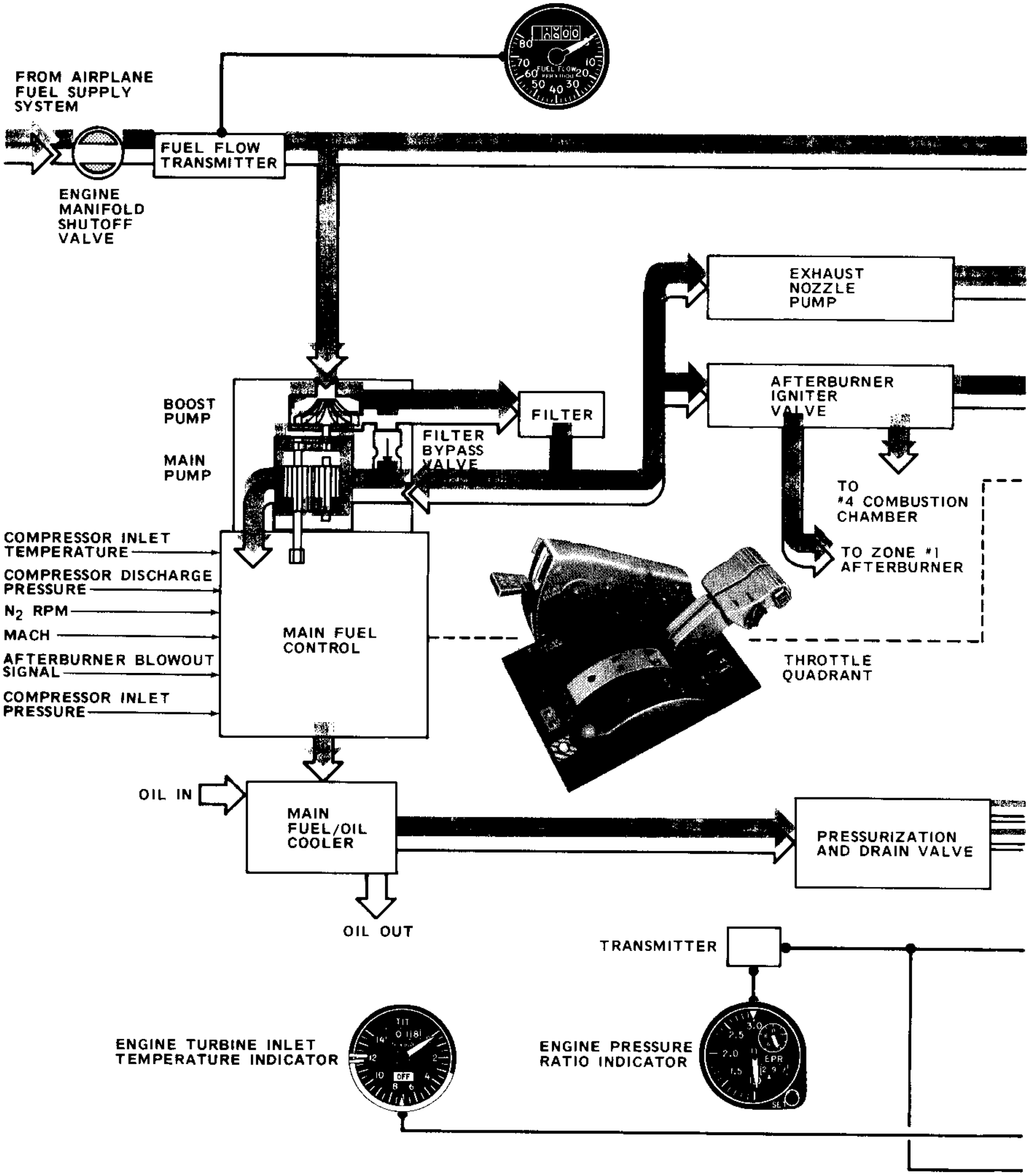

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Figure 1-4. (Sheet 1)

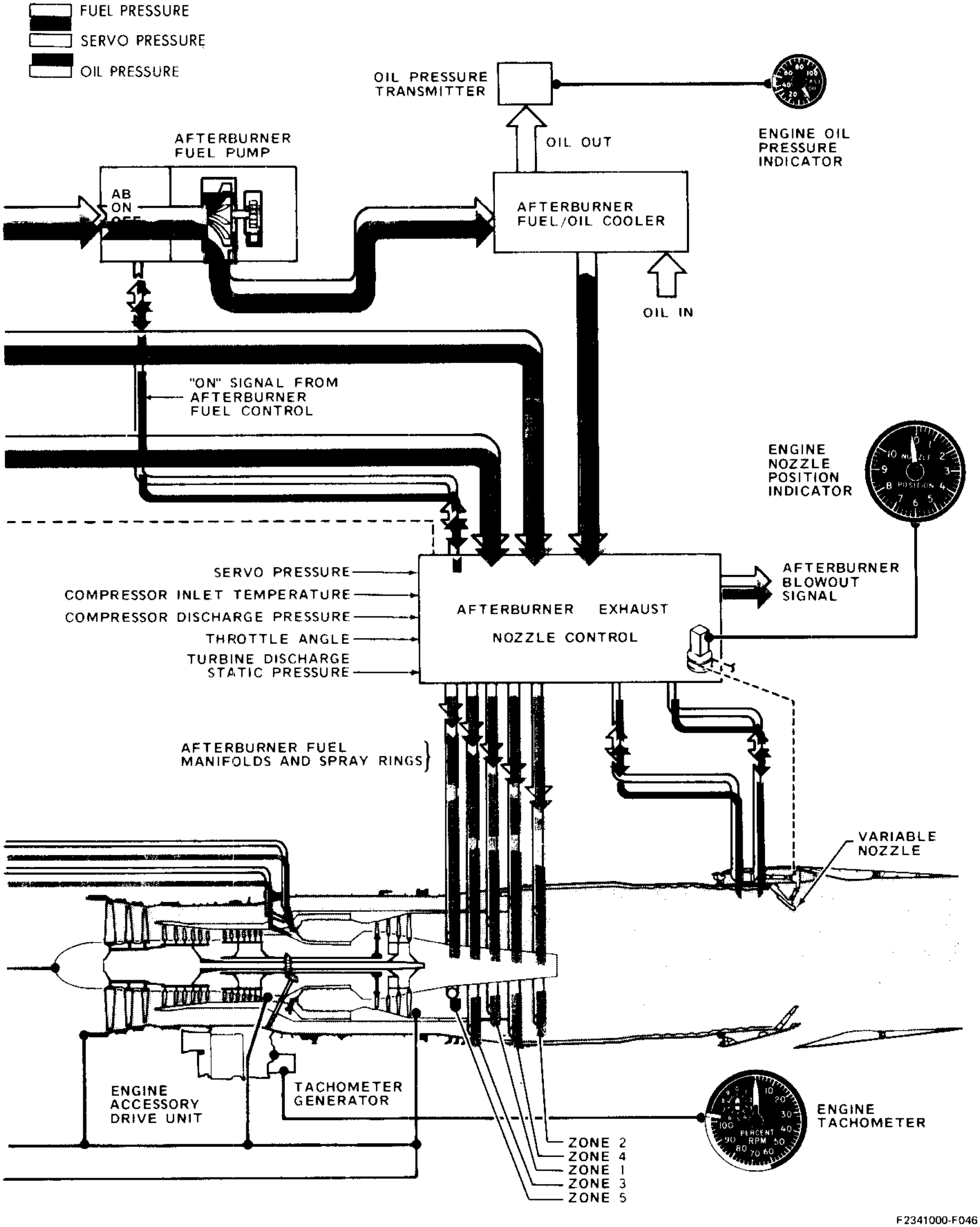


Figure 1-4. (Sheet 2)

ENGINE INLET SPIKES.

Engine inlet air velocity is regulated throughout the entire aircraft speed range in order to maintain maximum engine performance. This regulation of the air inlet velocity is accomplished by a movable spike located in the inlet of each engine. Each spike is a quarter circle, conical-shaped, variable diameter body that is independently movable forward and aft. The spikes are located in each air intake at the intersection of the wing lower surface and the fuselage boundary plate. Position and shape of the spikes are changed automatically to vary the inlet geometry and to control the inlet shock wave system. Local air pressure changes due to variation in inlet local mach and diffuser exit mach number are measured by sensors in the spike control unit. Signals from the control unit operate hydraulic actuators powered by the utility hydraulic system to position the spike fore and aft (extend or retract)and to adjust the spike cone angle by contracting and expanding the spike as required. When the aircraft is on the ground, and any time the aircraft speed is less than approximately mach 1.0, the spike will be full forward and fully retracted. In the event the system malfunctions, a one-shot pneumatic override system is provided to position and lock the spike full forward and fully contracted.

Note

Once the pneumatic override has been used, the hydraulic shuttle valves in the spike control system must be repositioned on the ground, with the utility hydraulic system depressurized.

An electronic anti-icing system prevents ice formation on the sensors. Refer to "Anti-Icing and Defog System", this section.

ENGINE INLET BLOW-IN DOORS.

The engine inlets are equipped with blow-in doors to provide an opening for additional air to the engine during ground operation and low speed flight. The doors are free floating so that they will automatically assume a position corresponding to the pressure differential between inlet duct and outside air pressure. On the ground and during low speed flight the doors will assume a position between full open and closed as this differential pressure varies with engine demand. As speed is increased the doors will close and remain closed when ram effect increases inlet pressure to above outside air pressure.

VORTEX DESTROYERS.

The possibility of ingestion of foreign objects into the engine during ground operation is reduced by an aerodynamic screen of engine bleed air which is directed down and outboard beneath each inlet through vortex destroyer air jets. The vortex destroyers serve to prevent the formation of vortexes below the inlet, thereby preventing foreign objects from being entrained in a vortex and sucked into the engine. When the weight of the aircraft is on the landing gear, a ground safety switch, located on the landing gear, automatically activates the vortex prevention air screen.

ENGINE VARIABLE EXHAUST NOZZLES.

The variable nozzle system incrementally opens and closes the engine exhaust nozzle for afterburner modulation. The control is a hydromechanical computing device that determines and sets the nozzle area required to maintain a desired turbine pressure ratio during afterburner operation. The nozzle position is scheduled by the throttle setting and governed by internal pressure ratio in the engine. The nozzle is closed for all ranges of nonafterburner operation except for ground engine idle, at which time it is positioned fully open for minimum thrust. If afterburner blowout occurs, the blowout signal valve is actuated, and the nozzle closes. In addition, the afterburner fuel selector valve closes off fuel flow to all afterburner zones, and a signal is directed to the engine main fuel control to reduce fuel flow to the main combustion chamber. When the nozzle has moved to the closed position, the blowout signal is removed. Afterburner operation can again be initiated; however, the throttle must first be moved to a nonafterburning position.

ENGINE IGNITION SYSTEM.

The functions of the engine ignition system are to provide a means of initiating combustion in the combustion chambers during the starting cycle and to provide a means for furnishing an engine ignition source in the event of a flameout. Each engine has a dual main ignition system including two ignition exciters, two igniter plugs, an ignition alternator, and an automatic restart switch. The alternator is engine driven and is capable of providing sufficient energy to both exciters of the ignition system for ground starting or for windmill starts during all flight conditions. Ignition alternator voltage is stepped up by transformer and capacitor circuits within the exciters to provide ionizing voltage for the igniter plugs. The alternator incorporates two independent current generating circuits for increased reliability. The automatic restart circuit energizes the ignition system in the event of a combustion chamber flameout by sensing the rate of change of burner pressure. This is accomplished by an automatic restart switch which will remain activated for 15 to 60 seconds depending on compressor discharge pressure. Engine ignition is accomplished by the two spark igniters located in the lower combustion chambers (No. 4 and No. 5) of each engine. Advancing the throttle from OFF position actuates the throttle ignition switch for that engine. This action provides ignition when the engine start switch is in PNEU or CARTRIDGE. Electrical ignition is cut off when the ground start switch returns to OFF. This normally occurs when the starter centrifugal cutout switch opens on the last

engine to be started. Ignition is also cut off when the throttle is retarded to the OFF position.

ENGINE STARTING SYSTEM.

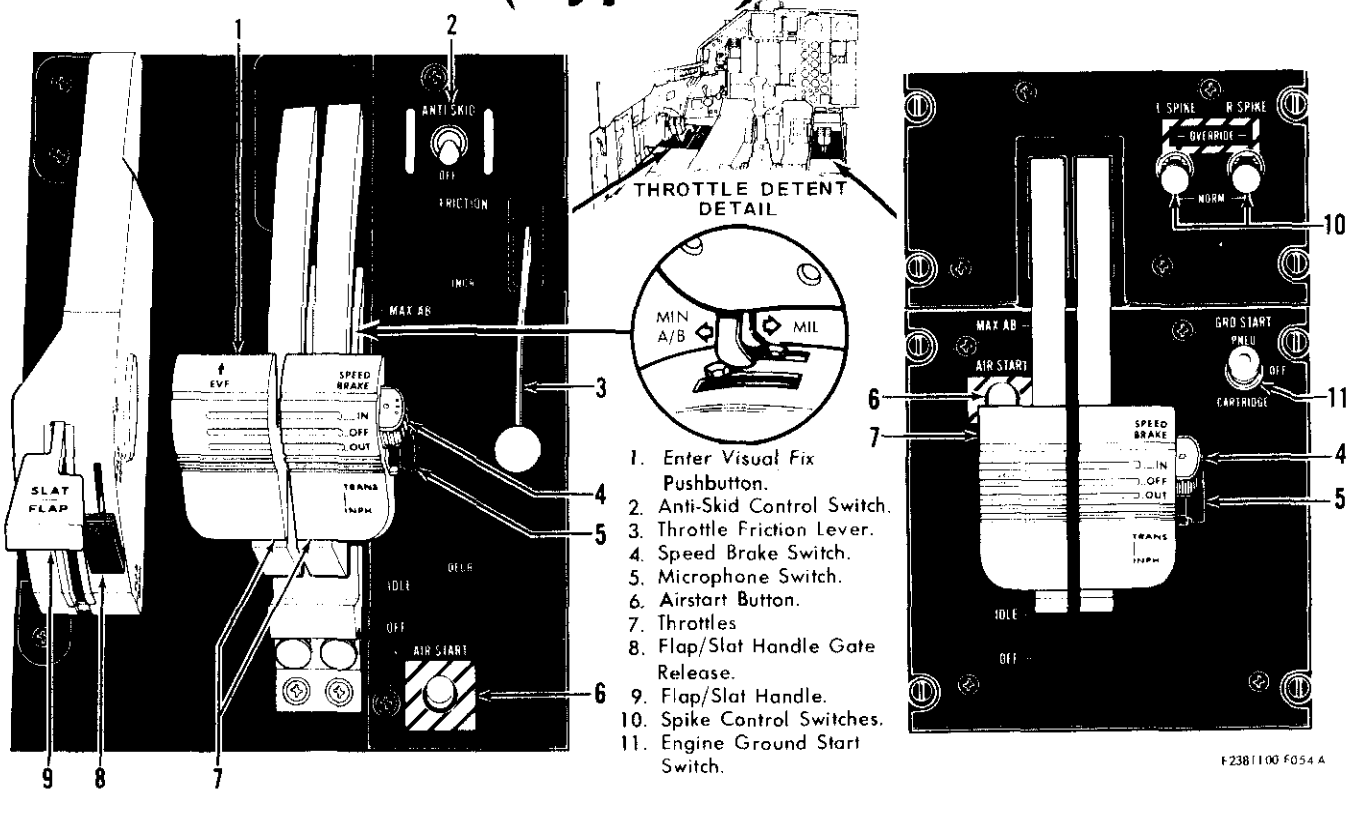
Several means are provided for starting the engines. The left engine can be started by pyrotechnic cartridge, both engines can be started by external pneumatic pressure, and once either engine is running, the remaining engine can be started by pneumatic crossbleed from the operating engine. The left engine is equipped with a cartridge-pneumatic starter to provide flexibility of operation without ground support equipment. The right engine is equipped with a pneumatic starter only. Electrical power required for starting can be obtained from either an external ground source or the aircraft battery. When starting the left engine with the cartridge, the cartridge is ignited by placing the ground start switch to CARTRIDGE and lifting the left throttle out of the OFF position. When starting the engines with a pneumatic source, either external or crossbleed, placing the ground start switch to PNEU and lifting the left or right throttle out of the OFF position, opens the starter pressure shutoff valve on the engine being started and allows pneumatic pressure to drive the respective starter. After a pneumatic start, the ground start switch will return to OFF when the centrifugal cutout switch in the starter on the second engine started opens. This breaks the starter control circuit and allows the starter pressure shutoff valve to close, shutting off the pneumatic pressure. Two spare cartridges can be carried in the main landing gear wheel well. An engine start counter, located in the left forward equipment bay, separately records the number of cartridge and pneumatic starts for each engine.

ENGINE CONTROLS AND INDICATORS.

Throttles.

A set of throttles (7, figure 1-5), is provided for both crew members. The respective left and right throttles in each set are mechanically linked together. Each throttle provides thrust setting adjustment for its respective engine. Pneumatic power boost, from the cabin pressurization sytem, is provided to assist throttle movement. Throttle friction for both sets of throttles is controlled by means of the friction lever located adjacent to the left set. Moving the lever toward INCR increases throttle friction, and moving the lever toward DECR decreases the friction. Force required to move the throttles varies from 2 to 30 pounds, with pneumatic boost, depending on the position of the friction lever. In the event pneumatic boost is lost, the force required to move the throttles is from 10 to 40 pounds depending on the friction lever position. Both

Throttle Panels (Typical)



1. Enter Visual Fix Pushbutton.
2. Anti-Skid Control Switch.
3. Throttle Friction Lever.
4. Speed Brake Switch.
5. Microphone Switch.
6. Airstart Button.
7. Throttles
8. Flap/Slat Handle Gate Release.
9. Flap/Slat Handle.
10. Spike Control Switches.
11. Engine Ground Start Switch.

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Figure 1-5.

sets of throttles have positions marked OFF, IDLE, MIL, and MAX AB, respectively. Only the left set of throttles can be raised to go into or from the OFF position. The center throttles cannot be used for engine starting or shutdown. When the left set of throttles are lifted to move them out of the OFF position, the throttle starter switches are actuated. If the ground start switch is in the CARTRIDGE position, lifting the left throttle will automatically fire the left engine starter cartridge. If the ground start switch is in the PNEU position, lifting either throttle will open the starter pneumatic pressure shutoff valve on the respective engine to allow starting by pneumatic pressure. Movement of either throttle forward of the OFF position activates the respective engine ignition system. A detent at the MIL position provides a means of readily selecting military power. A detent is also provided at the minimum AB position. To attain the minimum AB detent position the throttle must first be advanced into the afterburner range and then retarded until the detent is felt. Refer to figure 1-5 for a detail of both the MIL and MIN AB throttle positions. The left throttle of the left set includes an EVF (enter visual fix) button for updating the bomb nav system. The right throttle of each set includes a microphone switch and a speed brake switch.

Engine Ground Start Switch.

The engine ground start switch (11, figure 1-5), located on the center throttle panel, is a three-position switch marked PNEU, OFF, and CARTRIDGE. The switch is solenoid held in the PNEU and CARTRIDGE positions and is spring-loaded to and locked in the OFF position. The switch toggle must be pulled out before it can be moved to either PNEU or CARTRIDGE. Placing the switch to either PNEU or CARTRIDGE position supplies power to arm the throttle start switches. With the switch in the PNEU position, lifting either throttle out of the OFF position allows electrical power from the respective throttle start switch to open the starter pressure shutoff valve on the engine being started. With the switch in the CARTRIDGE position, lifting the left throttle out of the OFF position allows electrical power from the throttle start switch to fire the cartridge. A centrifugal cutout switch in the starter of the last engine started will open the circuit to the solenoid holding the engine ground start switch, and it will return to OFF.

Note

> Nose wheel steering is inoperative when the engine ground start switch is out of the OFF position.

Air Start Buttons.

Two air start pushbuttons (6, figure 1-5), one located on each throttle panel, provide a means of obtaining ignition for air-starting the engines. The buttons are marked AIR START. When either air start button is momentarily depressed, the air start timer relay actuates and allows ignition alternator power to operate the ignition exciters for both engines. The relay will remain energized for approximately 55 seconds after the air start button is released, thereby providing ignition for this length of time.

Ground Ignition Cutoff Switch.

The ground ignition cutoff switch (10, figure 1-27), located on the ground check panel, is labeled GRD IGN and has two positions marked NORM and OFF. When the switch is in OFF, a relay, which deactivates the engine electrical ignition system for both engines by grounding the ignition alternator output, is energized. When the switch is in the NORM position, the relay is deactivated, and the ignition circuits are not grounded through this relay.

Mach Trim Test Switch.

The mach trim test switch (3, figure 1-27), located on the ground check panel, has two positions marked NORM and TEST. The switch is spring-loaded to the NORM position. The switch is provided for maintenance ground check of the engine mach lever on the fuel control unit.

Spike Control Switches.

Two spike control switches (10, figure 1-5), located on the center throttle panel, are labeled L SPIKE and R SPIKE, respectively. The switches are lever lock type switches with two positions marked OVERRIDE and NORM. In the NORM position the spikes are automatically controlled to maintain maximum engine performance. When either switch is positioned to OVERRIDE, pneumatic pressure is applied to the spike actuator to move the spike to the full forward and fully contracted position. The switch must be pulled out of the lock before it can be moved from either position.

Spike Test Buttons.

Two spike test buttons (2, figure 1-27), located on the ground check panel, are provided to check operation of the spikes. The buttons are marked L SPIKE and R SPIKE. Depressing and holding either button will cause the respective spike to move to the full aft, fully expanded position. The spike caution lamps will light while the spikes are in transit. When the buttons are released, the spikes will move to the full forward, fully contracted position.

Engine Tachometers.

Two engine tachometers (27, figure 1-6), located on the left main instrument panel, indicate the percent of rpm of the high pressure compressor (N2) in each engine.

Each tachometer main dial is graduated from 0 to 100 percent rpm in increments of 2 percent; the subdial is graduated from 0 to 10 percent in increments of 1 percent.

Engine Overspeed Caution Lamp.

Two amber engine overspeed lamps, one for each engine, are located on the main caution lamp panel (figure 1-29). When lighted the letters L ENG OVERSPEED and R ENG OVERSPEED are visible. The lamps light to indicate an engine overspeed of approximately 105 percent rpm and above. In addition, the lamps will light prior to engine start, provided there is electrical power on the airplane, and will go out prior to reaching idle rpm. The lamps operate on 28 volt dc electrical power from the essential dc bus.

Engine Fuel Flow Indicators.

Two engine fuel flow indicators (29, figure 1-6), located on the left main instrument panel, show fuel flow for each engine in pounds per hour. The indicators are calibrated from 0 to 80,000 pph in increments of 2000 pph. A digital readout of fuel flow is displayed on the face of the indicator. This readout shows fuel flow to the nearest 100 pph.

Engine Nozzle Position Indicators.

Two engine nozzle position indicators (30, figure 1-6), located on the left main instrument panel, show nozzle position. The indicators are calibrated from 0 (smallest nozzle area) to 10 (largest nozzle area). The indicators use 115 volt ac power from the left main ac bus.

Engine Oil Pressure Indicators.

Two engine oil pressure indicators (32, figure 1-6), located on the left main instrument panel, indicate engine oil pressure in pounds per square inch. The indicators are calibrated from 0 to 100 psi in increments of 5 psi. The oil pressure indicating system operates on 26 volts ac which has been reduced by a transformer which has an input of 115 volts ac from the ac essential bus.

Engine Pressure Ratio Indicator.

Two engine pressure ratio (EPR) indicators (31, figure 1-6), located on the left main instrument panel, indicate the ratio of turbine discharge pressure to engine inlet pressure. The main dial of each indicator is calibrated from 1.0 to 3.0 in 0.1 increments. A smaller circular dial (subdial) on the indicator face is calibrated in 0.01 increments for precise reading. A set button on the lower right of each indicator permits movement of a reference pointer on the perimeter of the indicator to serve as an index for computed EPR. The precise EPR position of the reference pointer is displayed by a digital readout window on the indicator face. 115 volt ac power to the indicators is supplied from the essential ac bus.

Engine Turbine Inlet Temperature Indicators.

Two engine turbine inlet temperature (TIT) indicators (28, figure 1-6), located on the left main instrument panel, show turbine inlet temperature in degrees centigrade. The indicator dials are graduated from 0 to 1400 degrees in 50 degree increments. In addition, a digital readout of turbine inlet temperature in two degree increments is displayed. Power to the TIT indicators is supplied from the 28 volt dc engine start bus thus operation is normal with battery power. A flag marked OFF appears on the face of the indicator when power to the indicator is interrupted.

Spike Caution Lamps.

Two amber spike caution lamps, one for the spike in each engine inlet, are located on the main caution lamp panel (figure 1-29). When lighted, the letters L ENG SPIKE and R ENG SPIKE, respectively, are visible. A spike caution lamp lights when the aircraft mach number is less than 0.35 and the respective spike is not full forward and fully contracted. When the spike control switch is placed to OVERRIDE, the spike caution lamp will light and remain on until the spike has reached the full forward and fully contracted position. During spike self-test the lamps will light until the spike has reached its full aft and full expanded position. The lamps operate on 28 volt dc electrical power from the essential dc bus.

Engine Oil Hot Caution Lamps.

The two engine oil hot caution lamps are located on the main caution lamp panel (figure 1-29). When the oil temperature of either engine exceeds 250 degrees F, the associated lamp will light. When lighted, the following letters will be visible in the lens of the respective lamp: L ENG OIL HOT and R ENG OIL HOT.

ENGINE FIRE DETECTION AND EXTINGUISHING SYSTEM.

Engine fire detection is provided by sensing elements routed throughout each engine compartment. Should a fire or overheat condition occur, the rise in temperature is detected by the sensors which light the respective left or right engine fire warning lamp. Shutoff valves are provided to isolate fuel and hydraulic fluid from the affected engine. After the shutoff valves are closed, fire extinguishing agent can be discharged into the affected engine compartment to put out the fire. The extinguishing agent is contained in a single container with a separate discharge valve for each engine. Self-test features are incorporated in the system for maintenance checks and troubleshooting. The fire extinguishing agent is available for one engine only.

Left Main Instrument Panel (Typical)

1. Engine Fire Pushbuttons Warning Lamps.
2. Agent Discharge/Fire Detect Test Switch.
3. External Stores Jettison Button.
4. Landing Gear Control Panel (See fig. 1-16).
5. Angle of Attack Indexer.
6. Upper Warning and Caution Lamp Panel.
7. Sam Sector Indicator.
8. Left Warning and Caution Panel.
9. Total Temperature Indicator.
10. Wing Sweep Flap/Slat Position Indicator.
11. Landing Gear Position Indicator Lamps.
12. Instrument System Coupler Control Panel.
13. Main Caution Lamp Panel.
14. Optical Display Sight Set (See fig. 1-66).
15. Upper Warning and Caution Lamp Panel.
16. Integrated Flight Instruments (See fig. 1-32).
17. Clock.
18. Control Surface Position Indicator.
19. Nosewheel Steering/Air Refueling Indicator Lamp.
20. Radar Altimeter.
21. Radar Altitude Low Warning Lamp.
22. Stall Warning Lamp.
23. Master Caution Lamp.
24. Bomb Nav. Distance Time Indicator.
25. Takeoff Trim Indicator Lamp.
26. Takeoff Trim Button.
27. Engine Tachometers.
28. Engine Turbine Inlet Temperature Indicators.
29. Engine Fuel Flow Indicators.
30. Engine Nozzle Position Indicators.
31. Engine Pressure Ratio Indicators.
32. Engine Oil Pressure Indicators.
33. Hydraulic System Pressure Indicators.
34. Fuel Quantity Indicator Selector Knob.
35. Air Refueling Receptacle Lights Control Knob.
36. Total/Select Fuel Quantity Indicator.
37. Fuel Quantity Indicator Test Button.
38. Fuselage Fuel Quantity Indicator.

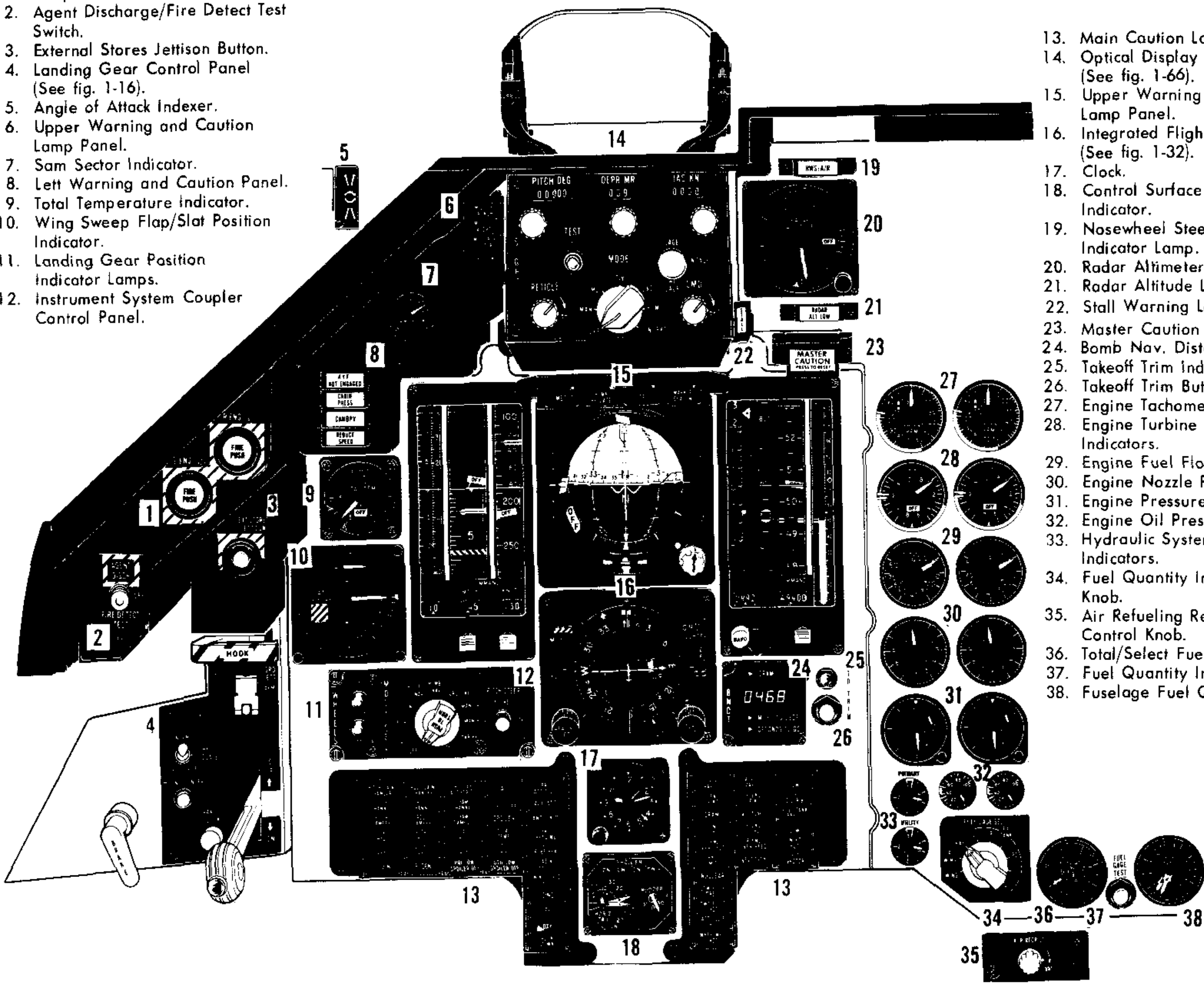

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Figure 1-6.

Selection of the engine to which the agent is to be directed is made by depressing the appropriate fire pushbutton.

Fire Pushbutton Warning Lamps.

Two fire pushbutton warning lamps (1, figure 1-6), labeled L ENG and R ENG, are located on the left main instrument panel. When a fire is indicated by a warning lamp, depressing either button will close the engine fuel shutoff valve and utility and primary hydraulic system shutoff valves to the respective engine and will arm the extinguishing agent discharge switch to the affected engine. Depressing the button again will open the fuel shutoff valve and disarm the fire extinguisher agent discharge valve; however, the hydraulic shutoff valves will remain closed. The buttons are covered by frangible covers to provide a visual indication that the buttons have been actuated.

WARNING

Caution must be exercised to prevent inadvertently depressing the wrong pushbutton and shutting down the good engine since the hydraulic shutoff valves cannot be reopened in-flight.

Agent Discharge/Fire Detect Test Switch.

The agent discharge/fire detect test switch (2, figure 1-6), located on the left main instrument panel, is a three-position lock lever switch marked AGENT DISCH, OFF, and FIRE DETECT TEST. The switch is spring-loaded to the OFF position, and is locked out of the AGENT DISCH position to prevent inadvertent actuation. To move the switch to AGENT DISCH, it must be pulled out of the lock. Momentarily positioning the switch to the AGENT DISCH position will discharge fire extinguishing agent into the engine compartment of the engine selected after depressing the affected engine fire pushbutton warning lamp. Holding the switch to the FIRE DETECT TEST position will light both fire warning lamps if the fire detection system is operational.

Fire Detection System Ground Test Switches.

Two fire detection system ground test switches (1, figure 1-27), located on the ground check panel, are labeled R ENG and L ENG. The switches have three positions marked CONTROL BOX, NORM, and ELEMENT and are used to ground check the system circuitry during maintenance or troubleshooting. Only one circuit can be checked at a time. On aircraft modified by T.O. 1F-111-611, the switches are spring-loaded to the NORM position.

Fire Detection System Short Test Button.

The fire detection system short test button (17, figure 1-27), located on the ground check panel, is marked SHORT TEST. The button is provided to ground check the system short discriminating test circuit during maintenance or troubleshooting.

ENGINE OPERATION.

The following paragraph, containing information pertinent to engine operation, will aid in the evaluation and correction of engine malfunctions. For a detailed discussion of "Engine Stall Characteristics", refer to Section VI.

Engine Acceleration.

Engine acceleration time is severely affected by the amount of compressor discharge air being bled from the engine and by outside temperature. The engine may require 15 seconds to accelerate from idle to military when air conditioning air is taken from that engine during ground operation. In flight this effect is minimized, but during final approach for landing, engine acceleration may require as much as 10 seconds to increase thrust from idle to military.

Afterburner Rumble.

During zone 4 and low zone 5 operation, the engine may exhibit afterburner fluctuations at 40 to 60 cps. This will be heard and felt as a low frequency beat-type vibration in the airframe and is referred to as afterburner rumble (rough combustion). Should this occur change throttle settings to a point where it can not be detected.

OIL SUPPLY SYSTEM.

Each engine is equipped with an oil supply system which consists of an oil tank, a main supply pump, six scavenger pumps, a deoiler, two filters, an overboard breather pressurizing valve, a pressure valve, and three oil coolers (air-oil, fuel-oil, and afterburner fuel-oil). The air-oil cooler operates with engine bleed air. Oil is fed to the main oil supply pump from the oil tank. It is then pumped in series through the two filters, the air-oil cooler, fuel-oil cooler, and afterburner fuel-oil cooler. Oil flow through the fuel-oil coolers is controlled by temperature and pressure sensing bypass valves. The oil is then directed to the engine bearings and to the accessory gearbox. Scavenger pumps return the oil to the oil tank. Capacity of the tank is five gallons, four gallons of which are usable. For oil specification and servicing location, see figure 1-80.

ENGINE OIL QUANTITY INDICATOR.

The engine oil quantity indicator, located on the auxiliary gage panel (4, figure 1-15), is a dual indicating instrument with two displays labeled L and R for the left and right engine, respectively. Each display is graduated from 0 to 16 in one quart increments. A pointer for each display provides an indication of the number of quarts of oil remaining in each oil tank. The indicator operates on 115 volt ac power from the left main ac bus.

Note

- The indicated oil quantity exhibits variations during normal operations. When a cold engine is started, the oil quantity indication may drop as much as five quarts at idle power settings. After an engine has warmed up, the oil quantity indications may vary as much as three quarts (increase or decrease) with varying power settings from IDLE to MIL.
- If the oil quantity indicating system for either engine malfunctions, that indicator will drive to below zero and the oil low caution lamp will be inoperative for that engine. The oil low caution lamp will, however, continue to monitor the oil quantity for the other engine. To confirm that the malfunction is in the oil quantity indicating system rather than an actual oil low condition, the oil low caution lamp may be checked by depressing the malfunction and indicator lamp test button, located on the lighting control panel.

OIL/OXYGEN QUANTITY INDICATOR TEST SWITCH.

The oil/oxygen quantity indicator test switch (6, figure 1-15), located on the auxiliary gage panel, is used to check the oil quantity indicator. The switch has three positions marked OXY QTY, OIL QTY and is spring-loaded to the center unmarked OFF position. Holding the switch to the OIL QTY position drives the left indicator to 5 quarts, the right indicator to 5.7 quarts and lights the oil low caution lamp. Refer to Oxygen System this section for the oxygen quantity indicator test functions of the switch.

OIL LOW CAUTION LAMP.

An oil low caution lamp (figure 1-29), located on the main caution lamp panel, lights any time the oil level in either the left or right engine oil supply tank drops to four (4) quarts usable oil remaining or when the test switch is used. When the lamp is lighted, the letters OIL LOW are visible.

FUEL SUPPLY SYSTEM.

The fuel supply system (figure 1-8) consists of a forward and aft integral fuselage tank, two integral wing tanks, an integral vent tank, and the associated fuel pumps, controls, and indicators. The fuel system employs twelve fuel pumps, of which six deliver fuel to the engines and six are used to transfer fuel from the wing tanks and weapons bay tanks to the fuselage tanks. Provisions are made for inflight refueling of the internal and external fuel tanks from a boom-type tanker aircraft. Single-point refueling is provided for ground servicing. All tanks are equipped with automatic refuel shutoff valves. Gravity refueling can be accomplished through filler caps in the wings and fuselage. For fuel tank capacities refer to figure 1-7.

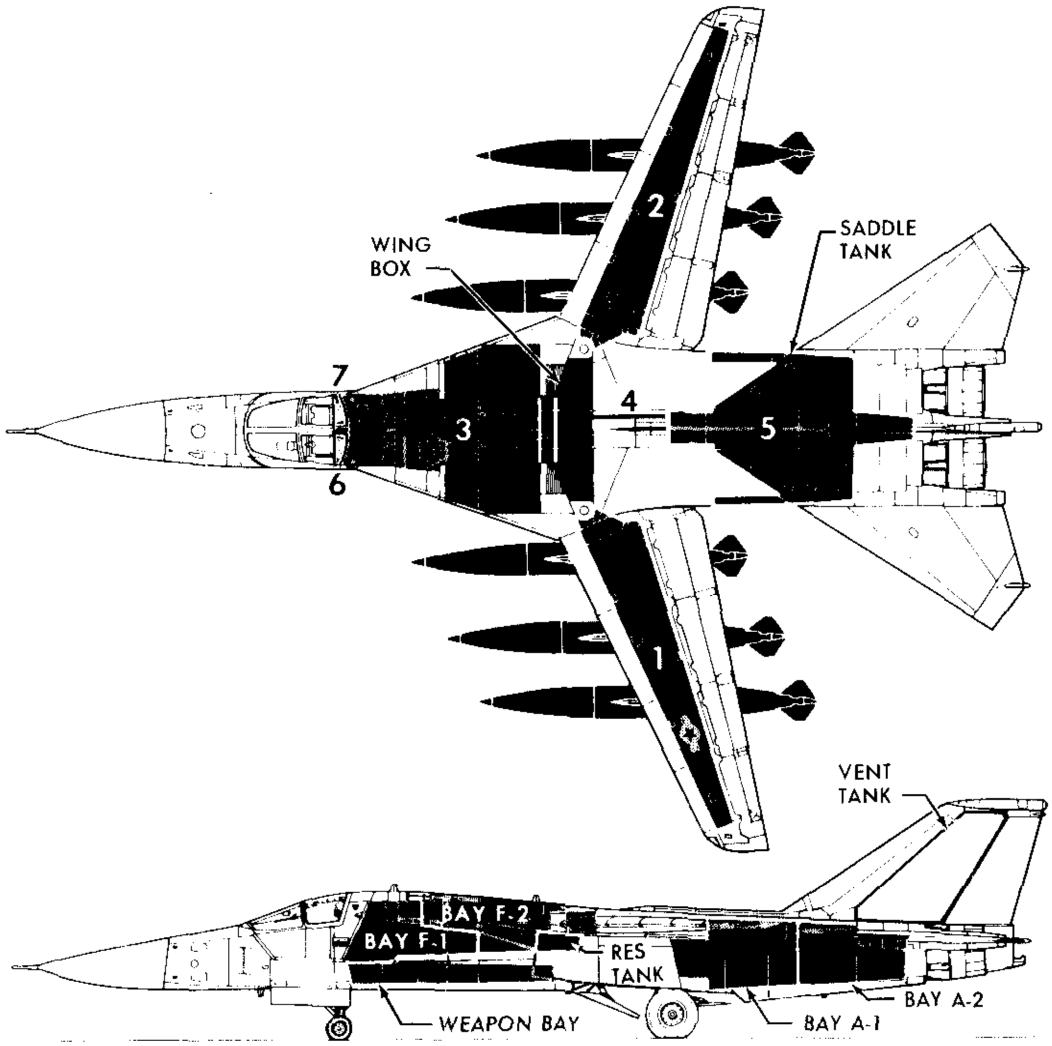
FUEL TANKS.

The fuel tanks consist of internal forward and aft fuselage tanks, left and right internal wing tanks, up to six detachable external wing tanks, two removable weapon bay tanks and an integral vent tank in the vertical stabilizer. See figure 1-7 for tank locations and capacities. The fuselage tanks are divided into compartments called bays. The forward fuselage tank is divided into bays F-1 and F-2 and a reservoir tank. The reservoir tank includes the fuel contained in the wing carry through box. Flapper valves allow fuel to flow from bay F-1 to bay F-2 and from Bay F-2 to the reservoir tank. The reservoir tank reserves approximately 2552 pounds of fuel after all other fuel in the system has been used. A float switch in the reservoir tank provides a caution lamp indication when the fuel level in the reservoir tank drops below 2300 ±235 pounds. The aft tank is divided into bay A-1, incorporating two "saddle" tanks, and bay A-2. Interconnecting stand pipes provide fuel flow between bays A-1 and A-2, and ejector pumps transfer saddle tank fuel into bay A-1. All fuel in the wing external and internal tanks and weapons bay tanks must be transferred into the fuselage tanks before it can be used. All tanks are pressurized by cooled engine compressor bleed air to prevent fuel vaporization. The vent tank provides space for expansion of fuel in the system when all tanks are fully serviced. Booster pumps in the fuselage tanks are provided for engine feed, and transfer of fuel from the aft to forward tank. Transfer pumps in the internal wing tanks and weapon bay tanks transfer fuel into the fuselage. Air pressure is used to transfer fuel from the external wing tanks.

FUEL QUANTITY MEASURING SYSTEM.

The fuel quantity measuring system is a basic capacitance sensing type system. There are four independent indicating functions: forward, aft, select, and total.

Fuel Quantity and Tank Arrangement (Typical)



LOCATION		QUANTITY			
		USABLE FUEL		FULLY SERVICED	
		GALLONS	POUNDS	GALLONS	POUNDS
1	LEFT WING INTERNAL TANK	389.2	2,530	390.7	2,540
2	RIGHT WING INTERNAL TANK	389.2	2,530	390.7	2,540
3	FORWARD FUSELAGE TANK	2,808.3	18,254	2,822.9	18,349
4	FUEL LINES	28.3	184	53.4	347
5	AFT FUSELAGE TANK	1,423.7	9,254	1,425.8	9,268
6	LEFT WEAPONS BAY TANK	284.6	1,852	287.4	1,868
7	RIGHT WEAPONS BAY TANK	299.7	1,948	300.9	1,956
TOTAL		5,623.0	36,552	5,671.8	36,868

NOTES:
1. These are average figures based on single point refueling at normal ramp attitude. Weights based on JP-4 fuel at 6.5 pounds per gallon. (Std. Day Only)

2. Each external tank, when carried, will have the following capacities.

USABLE FUEL		FULLY SERVICED	
GALLONS	POUNDS	GALLONS	POUNDS
600.0	3,900	602.2	3,914

F0000000 F009A

Figure 1-7.

Fuel Supply System

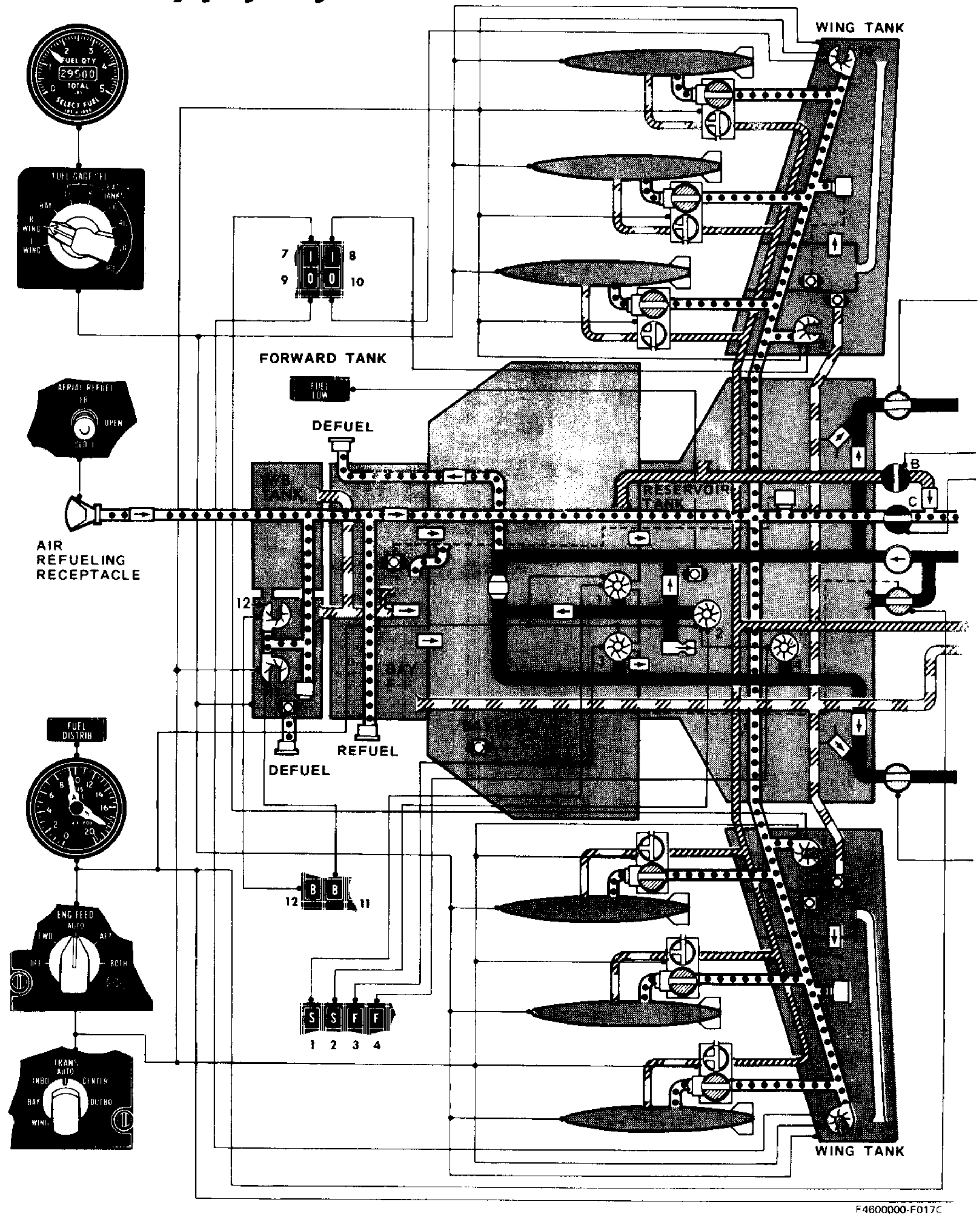


Figure 1-8. (Sheet 1)

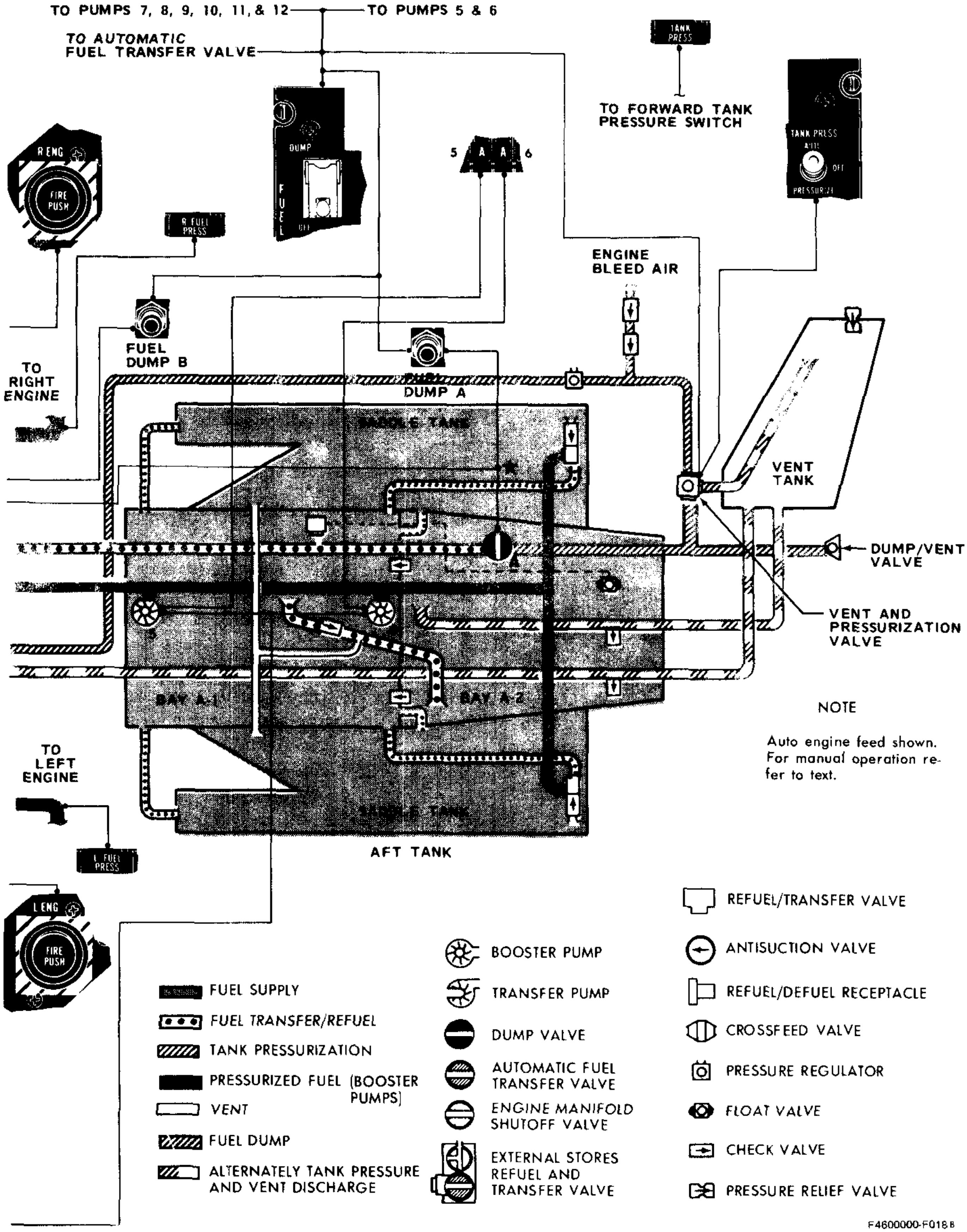


Figure 1-8. (Sheet 2)

Each consists of the following components: Capacitance sensors (tank units), located in each tank, provide a value proportional to fuel height/volume. An intermediate device measures the sum of tank units. A signal positions the indicator until a balance is established. The indicator consists of a servo, which responds to the amplifier; a gear train which drives the rebalance wiper; and a rebalance potentiometer. The four indicating functions are housed in the fuel quantity indicator and the total select fuel quantity indicator. The independence of the totalizer from possible errors occurring in the forward, aft, and select indicators is a design feature of this system and is made possible by use of dual sensor units in all tanks. Each indicating function has a capacitor that will always be covered with fuel until the respective tank is empty. An exception occurs in the select circuit in the aft tank. The fuel gage test circuit substitutes a fixed value which should indicate 2000 pounds. A normal response by the indicators verifies that the indicator circuit is functioning normally.

FUEL PUMPS.

There are 12 fuel pumps in the system. The six fuselage fuel pumps are dual inlet booster pumps, and the four wing fuel pumps are single inlet transfer pumps. Booster pumps 1 and 3 are in bay F-2, 2 and 4 are in the reservoir tank, and 5 and 6 are in bay A-1. Transfer pumps 7 and 9 are in the left wing, 8 and 10 are in the right wing and 11 and 12 are in the left weapons bay tank. Pumps 3, 4, 5 and 6 are the primary engine feed pumps, and 1 and 2 are standby engine feed pumps. Number 1 boost pump is a standby pump and operates continuously with the engine feed selector switch in any position except OFF. When not needed for engine fuel supply, the fuel provided by pump 1 is circulated into the reservoir tank through a pressure relief valve. The number 2 pump is energized by the pressure sensing switch when on AFT feed, BOTH or when on AUTO feed and the fuselage fuel quantity indicator indicates less than approximately 8500 pounds differential between the forward and aft tanks. All pumps are controlled by 28 volt dc power and are energized by 115 volt ac power from the following electrical busses:

AC POWER.

Pumps	*Bus*
1, 3, 6, 9, 10 and 11	R. Main
4, 5, 7, 8 and 12	Essential
2 only	L. Main

DC POWER.

Pumps	*Bus*
4, 5, 7, 8 and 12	Essential
1, 2, 3, 6, 9, 10 and 11	Main

ENGINE FUEL SUPPLY SYSTEM.

The engine fuel supply system functions in five modes to provide fuel flow to the engines and a control over the fuel distribution between the fuselage tanks. The five modes as selected with the engine feed selector knob are: AUTO, BOTH, FWD (forward), AFT and OFF. In the AUTO mode the fuselage fuel quantity indicator automatically maintains the fuel distribution between the fuselage tanks within prescribed limits to assure aircraft center-of-gravity. Refer to "Automatic Fuel Distribution (Primary)," this section, for description of operation in the AUTO mode. In the OFF mode, the engines are supplied with fuel by gravity (suction) from the forward tank. In the BOTH mode of operation, the left engine is fed from the forward tank and the right engine is fed from the aft tank. In this mode there is no automatic fuel distribution control and forward and aft tank fuel differential must be controlled by monitoring the fuselage fuel quantity indicator and manually selecting either FWD, AFT, or BOTH feed. In the event the fuselage fuel quantity indicator is inoperative or malfunctions refer to "Abnormal Fuel Distribution/Indication," Section III. During FWD or AFT mode operation, both engines are fed from the forward or aft tank respectively. When on AFT feed, under conditions of high fuel flow, the forward standby pumps will assist in meeting the high demand on an aft tank. In the event of loss of electrical power to the fuel system the engines will gravity (suction) feed from the forward tank.

AUTOMATIC FUEL DISTRIBUTION (PRIMARY).

In the AUTO mode, the fuselage fuel distribution is controlled by the F (forward) and A (aft) pointers. The engines are supplied fuel from the forward tank or both tanks depending upon the position of the switches in the indicator. If the differential in the forward tank is greater than approximately 8500 pounds,

as is the case when the tanks are fully serviced and until all wing and external fuel has been transferred into the forward tank, the indicator will turn the aft tank pumps off, and feed both engines from the forward tank. As the differential between the tanks is decreased to approximately 8200 pounds, the indicator will detect the proper fuel distribution and feed the left engine from the forward tank and the right engine from the aft tank. When the differential between the tanks decreases to approximately 7900 pounds, the indicator will open an automatic transfer valve, to transfer fuel forward and regain the proper fuel distribution.

WARNING

The use of AUTO engine feed when the fuselage fuel quantity indicator is malfunctioning or inoperative could result in exceeding the center-of-gravity limits and loss of control of the aircraft.

Additionally, a mechanical float valve, located in the forward tank, allows the automatic transfer valve to open when the fuel level drops below 9000 pounds. If the engine feed selector knob is placed to a position that will cause the aft tank pumps to operate, fuel will be transferred forward to maintain the 9000 pound level until the aft tank is empty.

ALTERNATE FUEL DISTRIBUTION MONITORING SYSTEM.

An alternate fuel distribution monitoring system provides a means to monitor fuel distribution between the forward and aft tanks independent of the fuel quantity indication system. The system includes four fuel level sensing units and a control unit. Two of the sensors are installed in the forward tank and two in the aft tank. One sensor in the forward tank is located at a fuel level of approximately 12,000 pounds, the other at about 9000 pounds. Likewise the two in the aft tank are located at approximately 5300 pounds and 2500 pounds. When operating in OFF, FWD, AFT or BOTH and the forward tank fuel level drops below the 12,000 pound sensor, a signal will be provided to turn the fuel distribution caution lamp on if the 5300 pound sensor in the aft tank is covered. Likewise when the fuel level in the forward tank decreases to a point below the 9000 pound level, the fuel distribution caution lamp will light if the aft tank level is above the 2500 pound sensor. A 12 second time delay is provided to eliminate fuel distribution signals due to fuel sloshing. When operating in AUTO, the alternate fuel distribution monitoring system is a back-up to the normal system. If a malfunction occurs in the automatic fuel distribution control system that allows the actual fuel distribution to reach the above conditions, the alternate monitoring system will light the fuel distribution caution lamp and turn on the aft tank pumps if they were not operating.

FUEL TRANSFER.

In order to use the fuel in the external tanks, internal wing tanks, or weapons bay tanks, it must first be transferred to the fuselage tanks. Normally the tanks are emptied in the order of external, weapons bay, and then internal wing tanks. Fuel transfer is controlled by the transfer knob. The fuel level in the fuselage is maintained by float valves which open or close refuel valves to allow transfer into the fuselage tanks anytime they are not full. The refuel valves cannot be controlled from the cockpit. Transfer from any pair of external tanks, the weapons bay tank, or internal wing tanks can be manually selected. (Refer to "Fuel System Operation," this section.) When automatic transfer is selected, the transfer of fuel is automatically sequenced from the outboard, center, and inboard external tanks; the weapons bay tanks; and then the internal wing tanks, in that order.

Note

Both external tanks in a pair must be empty before auto transfer will commence from the next pair.

When the weapons bay tank runs dry, a one-minute delay will occur to assure complete scavenging of the tank before the wing tanks will transfer. Transfer from the weapons bay and internal wing tanks is effected by transfer pumps. Transfer from the external wing tank is accomplished by pressurizing the selected tanks with cooled engine compressor bleed air at 36 to 41 psi. When transferring from the weapons bay tank or wing tanks, the fuel pump low pressure indicator lamps should be used in conjunction with the fuel quantity indicator to determine when the particular tank is empty. The exact fuel quantity where the individual wing pump lamps light cannot be established accurately because it depends upon a large number of variables; attitude, wing sweep, roll angle, load factors, fuel temperature and density, weapon loading, wing deflection, etc. However, for level flight with the wing sweep forward, the outboard pumps normally run out of fuel and cause the outboard pump low pressure lamp to light before the inboard pump lights. If the wings are swept aft, the reverse is true.

FUEL PRESSURIZATION AND VENT SYSTEM.

Fuel system pressurization is provided to prevent loss of fuel from vaporization during flight. All tanks are pressurized by this system except the external tanks. Pressurization is provided by cooled engine compressor bleed air. The system functions in two modes: automatic and manual, as controlled by a fuel tank pressurization selector switch. In the automatic mode the tanks are pressurized when the landing gear is retracted. In this mode the system is automatically

depressurized when the refueling receptacle door is opened or when the gear is extended. The tanks can also be pressurized by manually placing the fuel tank pressurization switch to PRESSURIZE in the event the automatic feature fails or if it is desired to pressurize the tanks with the air refueling receptacle door open or when the landing gear is down. The system maintains a pressure differential of 5 to 6 psi by means of a fuel tank vent and pressurization control valve. Should the pressure exceed 6 psi the valve will open and vent the excess air overboard through the dump/vent outlet at the rear of the fuselage. Except when transferring fuel from them, the external tanks are vented to atmospheric pressure through a vent port at the trailing edge of each pylon. Engine compressor bleed air at 36 to 41 psi is used to pressurize the external tanks for fuel transfer. The fuel transfer knob controls servo air to pressurize the external tanks. This is independent of the fuel tank pressurization system; however, engine bleed air must be available as selected by the air source selector.

FUEL DUMP SYSTEM.

The fuel dump system provides the capability of jettisoning fuel at a rate of 2300 pounds per minute. Fuel tank pressurization provides the force to jettison the fuel from the forward tank into the dump manifold and overboard through the vent/dump outlet at the aft end of the fuselage. This flow is controlled by motor operated dump valves A and B which receive power through circuit breakers located in the crew compartment. These two valves provide redundant shutoff capability for the dump system and valves are normally closed except during dumping operation. Dump valve B normally prevents fuel loss from the forward tank in the event of a broken refuel/dump line. Dump valve A normally prevents refuel and transfer flow from going overboard through the vent/dump outlet. In addition to dump valves A and B, dump valve C is provided. This valve is normally open but closes during dumping operation to prevent tank pressurization from flowing overboard through the dump line from the wings when the wing tanks are empty. Dump valve C receives power from dump A circuit breaker. The fuel dump system also utilizes the fuel transfer system to transfer fuel from the aft, bay and wing tanks to the forward tank. This is accomplished by relays which also receive power from dump B circuit breaker through the dump switch. When DUMP is selected, fuel immediately starts to transfer from the aft and wing tanks. Weapons bay tanks (if installed) will transfer before the wing tanks.

AIR REFUELING SYSTEM.

The air refueling system is capable of receiving fuel from a flying-boom type tanker aircraft. The system consists of a hydraulically actuated receptacle and slipway door, a signal amplifier, and the associated controls and indicators. Hydraulic pressure for operation of the receptacle and its latch mechanism is supplied by the utility hydraulic system. The receptacle is located on top of the fuselage, offset to the left and aft of the crew module. When the receptacle is extended, a mechanical linkage retracts the aft end of the slipway door into the fuselage, forming a slipway into the receptacle. When retracted, the slipway door is flush with the fuselage skin. The refueling receptacle is equipped with two lamps, one located on each side. As the receptacle extends, the lamps will light the receptacle and slipway area. During normal refueling operations, the refueling boom enters the receptacle and is automatically latched in place by a hydraulically actuated latching mechanism. When the boom is latched in place, fuel flows through the receptacle and the refuel/transfer fuel manifold lines into the fuel tanks at a rate of 5100 to 5800 pounds per minute. As the tanks are filled, float-operated valves automatically close the tank refueling valves, shutting off flow to the tanks. When the last refuel valve closes, an increase in the refuel line pressure is sensed by a pressure switch which automatically provides a signal to unlatch the boom from the receptacle. A disconnect signal can be manually initiated at any time during refueling by either receiver pilot or by the tanker boom operator. If a disconnect cannot be made by other methods, a brute force pullout can be safely accomplished. An emergency boom latch (EBL) capability is provided to latch the boom in place in the event the boom will not latch in the receptacle during normal operation. The EBL function also provides pneumatic power to extend the receptacle in the event utility hydraulic pressure is lost. Sufficient pneumatic pressure is available to operate the receptacle through two cycles (open and close) with four hookups during each cycle.

SINGLE-POINT REFUELING SYSTEM.

The single-point refueling system enables all aircraft fuel tanks to be pressure filled simultaneously from a single refueling receptacle. During ground refueling operations, fuel flows through the refueling receptacle and refueling manifold into the fuel tanks. As each tank fills, a float-operated valve automatically closes the refuel valve, stopping flow to the tank. The single-point refueling receptacle is located on the left side of the fuselage, forward of the engine air intake.

GRAVITY REFUELING.

Gravity refueling is accomplished through filler caps in the top of the wing and fuselage. There is one filler cap in each wing on the trailing edge near the fuselage. There are four filler caps in the fuselage: one each for F-1, F-2, A-1 and A-2 tanks. In addition to the filler cap located above the right saddle tank in bay A-1, a vent cap is provided above the left saddle tank. This cap must be removed to allow air to escape while the tank is being filled from the right side. To service the reservoir (trap) tank during gravity

refueling, the booster pumps in the foward tank must be operated at least two minutes. The external tanks can be refilled by transferring fuel from the wing tanks. The weapon bay tanks cannot be serviced by gravity refueling. For detailed gravity refueling, refer to "Strange Field," Section II.

FUEL SYSTEM CONTROLS AND INDICATORS.

Engine Feed Selector Knob.

The engine feed selector knob (6, figure 1-9), located on the fuel control panel, has five positions marked OFF, FWD, AUTO, AFT, and BOTH. When the knob is rotated to OFF, all fuel boost pumps are de-energized. Each knob position will energize the following pumps or place them on standby as indicated:

FWD —1, 2, 3 and 4 energized.

AUTO—Fwd & Aft fuselage fuel quantity indicator differential 8200 (approx.); 1, 3, 4, 5 & 6 energized; 2 on standby.

Fwd & Aft fuselage fuel quantity indicator differential approximately 7900 or less; 1, 3, 4, 5 & 6 energized, 2 on standby.

Fwd & Aft fuselage fuel quantity indicator differential approximately 8500 or greater; 1, 2, 3 & 4 energized.

AFT —1, 5 & 6 energized, 2 on standby.

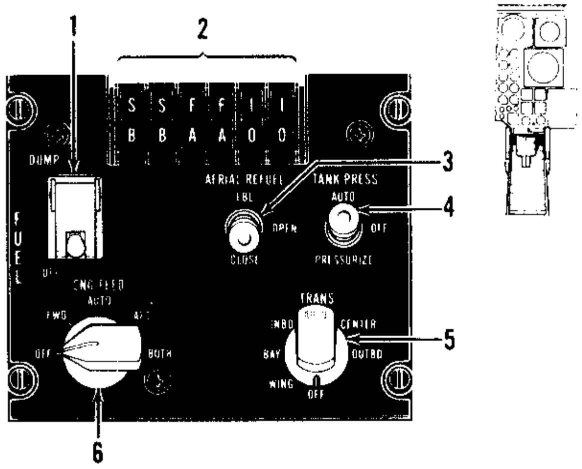
BOTH—1, 3, 4, 5 & 6 energized, 2 on standby.

When the knob is placed to FWD both engines are fed from the forward tank. When the knob is placed to the AUTO position the fuselage fuel quantity indicator, controlled by the F (forward) and A (aft) pointers on the instrument, automatically maintains the fuel distribution between the fuselage tanks within prescribed limits to assure aircraft center-of-gravity. The engines are supplied fuel from the forward tank or both tanks depending upon the position of the pointers. When the knob is placed to AFT, both engines are fed from the aft tank. However, when on AFT feed under conditions of high fuel flow, the forward standby pumps will assist in meeting the high demand on the aft tank. The standby pumps will also feed the engines from the forward tank should the aft tank run dry when on AFT feed.

WARNING

Do not use AFT feed when negative "g" operation is anticipated. Under negative "g" conditions only number 2 standby pump will be feeding the engines and engine flameout could result at MIL power or above.

Fuel Control Panel



1. Fuel Dump Switch.
2. Fuel Pump Low Pressure Indicator Lamps.
3. Air Refueling Switch.
4. Fuel Tank Pressurization Selector Switch.
5. Fuel Transfer Knob.
6. Engine Feed Selector Knob.

F4670000-F020B

Figure 1-9.

When the knob is placed to the BOTH position the left engine is fed from the forward tank and the right engine is fed from the aft tank. In this position there is no automatic fuel distribution control and forward and aft tank fuel differential must be controlled by monitoring the fuselage fuel quantity indicator and manually selecting either FWD, AFT, or BOTH feed.

Note

- The knob must be in either the AUTO or BOTH position to enable the functions of the air refueling switch.
- A failure of the auto transfer valve in the open position when the engine feed selector is in BOTH or AFT will cause all fuel in the aft tank to be transferred into the forward tank until full and may transfer into the wing tanks then through the vent tank and then overboard through the dump/vent valve. In the AUTO position a failure will result in stopping and starting of the aft tank pumps to maintain proper distribution and will not result in overfilling of the forward tank.

Fuel Transfer Knob.

The fuel transfer knob (5, figure 1-9), located on the fuel control panel, has seven positions marked WING, BAY, INBD, AUTO, CENTER, OUTBD, and OFF. When the knob is in the OFF position, all fuel transfer functions are off. When the knob is rotated to WING, four transfer pumps, two in each wing tank, are energized; and fuel is transferred from the wing tanks to the fuselage tanks. When the knob is positioned to BAY, two transfer pumps in the left weapons bay tank are energized to transfer fuel to the fuselage tank. The INBD, CENTER, and OUTBD positions of the knob are for transferring fuel from external tanks when installed. The AUTO position automatically sequences the transfer of fuel from the outboard, center, and inboard external tanks, weapons bay tank, and the wing tanks in that order. If an external tank is not installed, the sequence of transfer remains the same, except the missing tank is skipped.

Note

- When all fuel has been transferred, as indicated by the fuel quantity indicator and fuel pump low pressure indicator lamps, the knob should be turned to OFF. This will prevent excessive fuel transfer pump wear, conserve electric power and turn off the fuel pump indicator lamps.
- The fuel transfer knob must be in the OFF position to allow refueling the wing and weapons bay tanks. Common fuel manifold lines are utilized for both fuel transfer and refueling; therefore, if the transfer system is maintaining pressure in the manifold the refueling valves in these tanks cannot open to allow refueling.

Fuel Dump Switch.

The fuel dump switch (1, figure 1-9), located on the fuel control panel, is a two-position switch marked DUMP and OFF. A guard holds the switch in the OFF position to prevent inadvertent actuation. The functions of this switch are explained under "Fuel Dump System," this section.

Fuel Tank Pressurization Selector Switch.

The fuel tank pressurization selector switch (4, figure 1-9), located on the fuel control panel, is a three-position, lever-lock switch marked AUTO, OFF, and PRESSURIZE. When the switch is positioned to AUTO, the fuel tanks are pressurized, except when the landing gear is down or the air refueling door is open. When the switch is placed to OFF, the pressurization airflow to the tanks is turned off and the tanks are vented. When the switch is placed to PRESSURIZE and pressurization air is available, fuel tank pressurization is maintained with the landing gear down or the refuel door open. Pressurization of the fuel tanks will not be provided when the air source selector knob is in OFF or EMER position.

Air Refueling Switch.

The air refueling switch (3, figure 1-9), located on the fuel control panel, is a three-position, lever-lock toggle switch marked EBL, OPEN, and CLOSE. (Refer to "Air Refueling," this section, for operation of air refueling.)

Nose Wheel Steering/Air Refuel Buttons.

The nose wheel steering/air refuel buttons (3, figure 1-24), one located on each control stick grip are labeled NWS and A/R DISC. The air refueling functions of the buttons are activated when the aircraft is airborne to provide a means of manually disconnecting the air refueling boom. Depressing either button will interrupt power to the boom latching mechanism, causing it to unlatch. For a description of the NWS function of the buttons, refer to "Nose Wheel Steering System," this section.

Position Lights/Stores Refuel Battery Power Switch.

The position lights/stores refuel battery power switch (5, figure 1-27), located on the ground check panel, has three positions marked POS LIGHTS, NORM, and STORES REFUEL. Placing the switch to the STORES REFUEL position will supply battery power directly from the battery bus to the external fuel tank valves for single-point ground refueling regardless of the position of the battery switch. A float switch in the external tank will break the circuit and shut off the flow of fuel when the tank is full. This position will also prevent fuel transfer from any external tank regardless of fuel control panel switch positions. Placing the switch to NORM de-energizes the circuit. The switch is mechanically held in the NORM position when the ground check panel door is closed. For a description of the POS LIGHTS position of the switch, refer to "Lighting System," this section.

Fuel Quantity Indicator Test Button.

The fuel quantity indicator test button (37, figure 1-6), located on the left main instrument panel, is provided to self test the fuel quantity indicators. The button has the additional function of self-testing the alternate fuel distribution monitoring system. When the button is depressed, the fuel quantity indicators will simultaneously drive to the following indications:

1. Forward and aft tank pointers 2000 ($\pm$400).
2. Select tank pointer 2000 ($\pm$100).
3. Total fuel digital counter 2000 ($\pm$1250).

The fuel distribution caution lamp will light 10 to 12 seconds after the test button has been held depressed, to indicate that the alternate fuel distribution monitoring system is operative. When the button is released, the fuel quantity indicators will return to their original readings and the fuel distribution caution lamp will go out in less than 15 seconds for all engine feed selector knob selections except AUTO. In the AUTO position, the lamp will remain on until the fuselage fuel quantity indicator pointers show a differential between the forward and aft tank greater than 7600 pounds. During the short period of time that the pointers show an abnormal fuel distribution (while they are returning to their original readings), the automatic fuel distribution control system will open the automatic fuel transfer valve and allow a small amount of fuel to be transferred from the aft to the forward tank.

Note

If fuel tank expansion space has been reduced due to fuel overfill or thermal expansion, some fuel venting may occur with the engine feed selector in AUTO, while the fuselage fuel quantity indicators are returning from the test indications. Fuel venting must cease prior to taxiing.

Fuel Quantity Indicator Selector Knob.

The fuel quantity indicator selector knob (34, figure 1-6), located on the left main instrument panel, has nine positions marked L WING, R WING, BAY (Weapons bay tank), LI (left inboard external tank), RI, LC (left center external tank), RC, LO (left outboard external tank), and RO. Placing the knob to the desired tank enables reading the amount of fuel remaining in that tank on the total/select fuel quantity indicator.

Note

Placing the fuel quantity indicator selector knob to an external or weapons bay tank position when there is no tank installed will result in a below zero indication.

Total/Select Fuel Quantity Indicator.

The total/select fuel quantity indicator (36, figure 1-6), located on the left main instrument panel, provides indications of total fuel in all tanks and fuel remaining in individual wing or external pylon tanks and the weapons bay tank. The indicator is graduated from 0 to 5 (times 1000 pounds) in increments of 100 pounds and has a pointer and a five-digit counter. The pointer will read the fuel remaining in the wing, bay, or external tank as selected by the fuel quantity indicator selector knob. The counter continuously reads the total fuel remaining in all tanks. Due to fuel quantity indicating system tolerance, it is possible to have a small amount of fuel remaining in the wing tanks when the select fuel indicator reads empty. The fuel pump low pressure indicator lamps for the wing transfer pumps provide the most positive indication that the wing tanks are completely empty. The select fuel quantity indicator circuit uses a single compensator sensor, located in the aft fuel tank, to correct for variations in fuel densities. If the aft tank is emptied while there is fuel in one or more of the wing or external tanks, or the weapons bay tank, the uncovering of the compensator will cause the select gage indications to read erroneously high. The actual error will depend on the amount of fuel remaining in other tanks, however, a maximum error of 1000 pounds could exist.

Fuselage Fuel Quantity Indicator.

The fuselage fuel quantity indicator (38, figure 1-6), located on the left main instrument panel, provides indications of the amount of fuel in the forward and aft fuselage tanks. In addition, when operating in automatic engine feed the indicator, through a series of internal switches controlled by the F (forward) and A (aft) pointers on the instrument, automatically maintains the fuel distribution between the fuselage tanks within prescribed limits to assure aircraft center-of-gravity. Refer to "Automatic Fuel Distribution (Primary)", this section, for a description of this function of the fuel quantity indicator.

WARNING

The use of AUTO engine feed when the fuselage fuel quantity indicator is malfunctioning or inoperative could result in exceeding the center-of-gravity limits and loss of control of the aircraft.

The indicator is graduated from 0 to 20 (times 1000 pounds) in 500 pound increments. The indicator has two pointers marked F (forward)and A (aft) for the forward and aft tanks. When operating in automatic engine feed, the A pointer will be maintained approximately 8200 pounds below the F pointer. In this position the F pointer will be between two dot indices on the outer scale of the indicator. One dot indicates the point at which aft to forward transfer will occur, and the other indicates the point at which the aft tank pumps are shut off to maintain the 8200 pound differential. Two bar indices outboard of the dots indicate the point at which the fuel distribution caution lamp will light to indicate that the fuel differental between the forward and aft tanks is out of tolerance. The indices move with the A pointer and provide a ready reference of fuel differential when operating in manual engine feed.

Fuel Manifold Low Pressure Caution Lamps.

Two amber fuel manifold low pressure caution lamps (figure 1-29) are located on the main caution lamp panel. The letters R FUEL PRESS or L FUEL PRESS are visible when the respective lamp is lighted. The applicable lamp lights any time the fuel pressure in the right or left fuel manifold is less than 15.5 psia.

Fuel Low Caution Lamp.

The amber fuel low caution lamp (figure 1-29) located on the main caution panel is controlled by a float switch in the reservoir tank. When the lamp is lighted, the letters FUEL LOW are visible indicating that the fuel level in the reservoir tank is less than 2300 (±235) pounds. With maximum gaging system tolerances, the "f" pointer may indicate as low as 1700 pounds or as high as 3000 pounds.

WARNING

Negative "g" operation must be avoided whenever the fuel low caution lamp is lighted. The fuel system can supply fuel to the engines during negative "g" operation for 10 seconds if the reservoir tank is initially full. There may be no negative "g" capability if the fuel low caution lamp is on, indicating that the reservoir tank is not full.

Note

If boost pump 1 fails to provide fuel circulation through the reservoir from bay F-2, the small amount of air trapped in the top of the wing carry through box may expand, lowering the fuel level and causing the fuel low caution lamp to light. Engine fuel supply, other than for negative "g", will not be jeopardized. During climb, with afterburners operating the fuel low caution lamp may occasionally light. This is caused by air from the fuel that collects at the top of the reservoir tank, allowing the fuel low float switch to actuate. This does not indicate a malfunction or constitute a hazardous condition for positive "g" flight. The lamp should go out after engine flow from the forward tank is reduced to less than 40,000 pounds per hour.

Fuel Pump Low Pressure Indicator Lamps.

Twelve fuel pump low pressure lamps (2, figure 1-9), one for each fuel pump, are located on the fuel control panel. When a fuel pump is energized, whether by automatic or manual tank selection, and the pump is not generating at least 3.5 (±0.5) psi, the lamp corresponding to the pump will light. The lamps are arranged in a double row, and the face of the lamps are marked in pairs to correspond to each pump as follows:

S—Standby pumps 1 and 2

F—Forward fuselage tank pumps 3 and 4

I—Wing tank inboard transfer pumps 7 and 8

B—Weapons bay tank transfer pumps 11 and 12

A—Aft fuselage tank pumps 5 and 6

O—Wing tank outboard transfer pumps 9 and 10.

Fuel Tank Pressurization Caution Lamp.

The amber fuel tank pressurization lamp (figure 1-29), located on the main caution lamp panel, lights when fuel tank air pressure drops below approximately 3.5 (±0.5) psi during flight with the landing gear and the air refueling receptacle retracted. The lamp also lights any time the fuel tanks are pressurized and the landing gear or air refueling receptacle is extended. When the lamp lights, the letters TANK PRESS are visible.

Note

During descent, with the engines at idle, engine bleed air pressure is reduced, resulting in a lower airflow rate to the fuel tanks. At descent rates greater than 6000 feet per minute, it is possible for the fuel tank pressure to drop below 3.5 psi, causing the lamp to light. This is not an indication of a malfunction or hazardous condition.

Fuel Distribution Caution Lamp.

The amber fuel distribution caution lamp (figure 1-29), located on the main caution lamp panel, is provided to indicate an abnormal fuel distribution between the forward and aft tanks. The lamp has two signal input sources: (1) With the engine feed selector in AUTO, the automatic fuel distribution control system will light the lamp if the differential between the F and A pointers becomes less than 7600 pounds or greater than 10,000 pounds. (2) With the engine feed selector in any position, including OFF, the alternate fuel distribution monitoring system will light the lamp for abnormal aft center-of-gravity conditions only. When the lamp is lighted, the letters FUEL DISTRIB are visible. For normal operation of the lamp during ground checkout, refer to "Fuel Quantity Indicator Test Button," this section.

Nose Wheel Steering/Air Refueling Indicator Lamp.

The nose wheel steering and air refueling indicator lamp (19, figure 1-6), located on the left main instrument panel, is labeled NWS A/R. For air refueling, the lamp indicates when the air refueling circuitry is set to receive the refueling boom. As the receptacle extends into place, the lamp will light. When the boom is latched in the receptacle, the lamp will go out. When the boom disconnects, the lamp will light again. When the air refueling switch is in the EBL position, the lamp indications are the same as when in normal operation, except the lamp will go out if the NWS A/R DISC button is depressed and the boom is not in the receptacle. The lamp will light when the NWS A/R DISC button is released if a disconnect has occurred. For a description of the NWS function of the lamp, refer to "Nose Wheel Steering" this section.

Fuel Tank Pressure Gage.

The tank pressure gage, located adjacent to the single-point refueling receptacle, is provided to monitor tank pressure during ground refueling. The gage is graduated from 0 to 15 psi, in 0.5 psi increments.

FUEL SYSTEM OPERATION.

The fuel system can be operated in either an automatic or manual mode. The automatic mode is normally used since it requires a minimum amount of crew monitoring. Manual mode serves primarily as a backup in the event automatic operation malfunctions.

Normal (Automatic) Operation.

Normal system operation is accomplished with both the engine feed selector and fuel transfer knobs in AUTO. In this configuration the following functions are automatically performed:

1. As fuselage fuel is used, fuel is transferred into the fuselage tanks from the external tanks, weapon bay tanks and internal wing tanks, in that sequence.
2. If all tanks were fully serviced at takeoff, both engines will be fed from the forward fuselage tank until external and internal wing tanks and weapon bay tank are expended and the fuel level in the forward tank is burned down to approximately 8200 pounds of fuel more than the aft tank. At this point the system will automatically switch to a split feed condition (feeding the right engine from the aft tank and the left engine from the forward tank) to maintain the differential thereby keeping the aircraft center-of-gravity within operational limits.
3. If the forward tank is burned down to approximately 7900 differential the automatic transfer valve will open to allow fuel to be transferred from the aft tank to the forward tank. This will reestablish the 8200 pound differential.
4. If the aft tank is burned down to 8500 pounds differential, the aft tank pumps are turned off and both engines are fed fom the forward tank until the 8200 pound differential is reestablished.

Manual Operation.

In the event that either automatic engine feed or automatic fuel transfer becomes inoperative, manual backup is available. During manual engine feed the forward tank must be maintained at least 8000 pounds more than the aft tank by manual selection of either FWD or AFT feed to establish the proper differential. Once the differential has been established BOTH should be selected to maintain the differential. During manual transfer the fuel transfer knob is positioned progressively to OUTBD, CENTER, INBD, BAY, and WING to empty the external wing, bay, and internal wing tanks, in that sequence. As each tank is selected for transfer, the corresponding fuel quantity indicator selector knob position should be selected to monitor the fuel level in the tank being emptied. It will be necessary to frequently switch the knob between the left and right external and internal wing tanks to monitor fuel transfer from these tanks.

Note

There should be a delay of approximately one minute after each tank(s) (external, bay or internal) indicates empty to insure all fuel is transferred before selecting the next tank.

Gravity Fuel Feed.

The engine driven fuel pumps will gravity (suction) feed the engines in the event of an electrical malfunction which prevents booster pump operation. In this condition, fuel will be used from the forward tank only. An anti-suction valve between the forward and aft tanks prevents suction feed from the aft tank to prevent the suction of air into the engine feed line in the event the aft tank is empty.

Fuel Dumping.

With the fuel dump switch in the OFF position, dump valves A and B are closed and C is open. When the switch is positioned to DUMP, the following events occur:

1. Dump valves A and B open and C closes.
2. The automatic transfer valve opens.

3. The fuel tanks pressurize (with the air source selector knob in any position other than OFF or EMER).
4. Booster pumps 5 and 6 in the aft tank transfer fuel to the forward tank (if in AUTO with more than 8,500 pounds differential, 6 only).
5. Transfer pumps 11 and 12 in the weapons bay tank, if installed, transfer fuel to the forward tank.
6. When the weapons bay tanks are empty, pumps 7, 8, 9 and 10 transfer fuel from the wing tanks to the forward tank.
7. Transfer from the external wing tanks, if selected, will continue at a reduced rate.

The fuel tanks will pressurize when the dump switch is in DUMP regardless of the position of the fuel tank pressurization selector switch, the landing gear handle, or the air refueling door, provided the air source selector knob is in a position other than OFF or EMER. Sufficient air is available to obtain the normal dump rate of 2300 pounds per minute when either engine RPM exceeds 85 percent. Tank pressurization forces fuel from the forward fuselage tank into the dump manifold and overboard through the vent/dump valve located on the aft centerbody. Fuel will be transferred from aft to forward tank at approximately 1750 pounds per minute if both aft tank pumps are operating or at 1100 pounds per minute if only one pump is operating. If external tank transfer is selected during a dumping operation, the rate of transfer from the external tanks is relatively slow; therefore, if required by operational considerations, these tanks should be jettisoned. All fuel except that in the reservoir tank (approximately 2552 pounds) can be dumped.

WARNING

To avoid the possibility of dumped fuel reentering the aircraft and causing a fire hazard, fuel dumping should be accomplished in straight and level flight at airspeeds no greater than 350 KIAS or mach 0.75, whichever is less.

Note

If dumping operation is necessary during afterburner operation, the fuel may ignite behind the aircraft. Other aircraft in the immediate vicinity should be advised to stay well clear during dumping operations.

To eliminate prolonged fuel dripping from the fuel dump outlet after dumping is discontinued, the fuel system may be momentarily depressurized to clear residual fuel from the fuel dump lines. (This will happen automatically when the landing gear is extended for landing.) During fuel dumping operations it should be noted that the automatic center-of-gravity control will not operate normally. If the engine feed selector knob is in AUTO during dumping, the No. 5 booster pump in the aft tank will shut off when the 8200 pound fuel differential is exceeded; the No. 6 booster pump will continue to run. Assuming that fuel is also being transferred from the wing tanks, the forward fuselage tank will remain full while the aft fuselage and wing tanks are emptying. This will cause the center-of-gravity to gradually shift forward and the 8200 pounds differential may not be maintained, causing the fuel distribution caution lamp to light. When the wing tanks are emptied, fuel from the forward fuselage tank will be dumped at a faster rate than that being transferred from the aft fuselage tank. This will cause the center-of-gravity to shift aft until the 8200 pound fuel differential is reestablished. From this point until the aft fuselage tank is empty, the No. 5 booster pump in the aft tank will cycle on and off to maintain the 8200 pound fuel differential. Although fuel is normally forced overboard by tank pressurization during fuel dumping, some dump capability still exists when tanks are not pressurized (air source selector knob in the OFF or EMER position). The fuel that is transferred to the forward tank will flow overboard, through the dump/vent outlet, at approximately the transfer rate, if the forward tank is nearly full. If the forward tank is not initially full, a portion of the fuel being transferred may partially fill the forward tank. After the tanks from which fuel is being transferred are empty, a portion of the fuel in the forward tank will flow overboard by gravity. The fuel flow rate from the forward tank will be approximately 500 pounds per minute when the tank is full, and will gradually decrease to zero. The quantity of fuel that can be dumped from the forward tank depends on the attitude of the aircraft, the higher the nose of the aircraft, the more fuel dumped. At level flight, the dump flow from the forward tank will cease at a fuel quantity in the forward tank of approximately 13,000 pounds. In order to obtain maximum fuel dump rate, without tank pressurization, the engine feed selector switch should be positioned to BOTH to prevent the automatic fuel distribution system from turning off the number 5 booster pump.

Air Refueling.

In order to open the receptacle the engine fuel feed selector must be selected to AUTO or BOTH, and the air refueling switch must be selected to OPEN or EBL. When the receptacle is open, the NWS A/R lamp will light to indicate the receptacle is open and the system is ready to accept the refueling probe.

Note

During ground operation when the air refueling door is open, the nose wheel steering/air refueling indicator lamp will light to indicate door position and nose wheel steering will function only while the NWS A/R DISC button is held depressed.

When the tanker/refueling probe is inserted into the receptacle, it is automatically latched in place and the NWS A/R lamp will go out to indicate when the latches have closed. Refueling is accomplished with the refuel switch selected to OPEN. In this position a disconnect signal can be provided from the tanker or from either crew member by use of the NWS A/R DISC button. In addition, when all tanks are full, fuel flow is interrupted by automatic closing of the refuel valves. A pressure switch will sense a rise in pressure in the refuel manifold and automatically provide a disconnect signal. Three seconds after the disconnect has occurred, the refuel system will automatically "reset" itself and light the NWS A/R lamp to indicate the system is again ready to receive a probe or that the receptacle should be closed. In addition, if the air refueling amplifier malfunctions, the EBL position on the air refuel switch will permit refueling. The procedure for EBL refueling is the same as the automatic procedure described above except a disconnect signal cannot be provided from any source other than the crew using the NWS A/R DISC button. When the button is depressed, the NWS A/R lamp will remain out until it is released. The NWS A/R lamp will light when the probe is out of the receptacle. If a malfunction of the hydraulic control solenoid has occurred that prevents opening of the receptacle, opening can then be accomplished by selecting EBL. This mode uses a separate solenoid to open the receptacle. Certain failures may require the air refuel circuit breaker to be reset after EBL is selected. In the event utility hydraulic power is not available, a back-up pneumatic system is provided. This system is energized by selecting EBL. Once in EBL, the OPEN position may be selected. This will allow the system to operate as it does in the OPEN position. Pneumatic power to operate the system will remain on until 5 seconds after the air refueling switch is placed to CLOSE. Sufficient pneumatic power is available to operate the receptacle through two cycles (open and close) with four hookups during each cycle. In the event of a failure that prevents a normal disconnect, a pressure relief valve is provided in the receptacle hydraulic latch actuator that will allow the probe to be pulled out by brute force if the boom tension exceeds 5000 pounds. Normal operating boom loads do not exceed 2300 pounds. Design loads for the receptacle and the tanker boom exceed 16,000 pounds. Lights are provided to illuminate the receptacle. The lights are turned on by a switch when the slipway door is open. The intensity of the lights is controlled, by the air refueling receptacle control knob. The knob should normally be at the mid-point of its control range when not in use. This assures that the lights are on at the beginning of night refueling but does not waste the service life of the bulbs during day refueling. Refer to T.O. 1-1C-1-1 for general air refueling procedures and T.O. 1-1C-1-21 for specific air refueling procedures for this aircraft.

ELECTRICAL POWER SUPPLY SYSTEM.

The electrical power supply system provides 115 volt, three-phase, 400-cycle ac power and 28 volt dc power. Two ac generator drive assemblies, one mounted on each engine, supply ac power. Two transformer rectifier units provide 28 volt dc power.

ALTERNATING CURRENT POWER SUPPLY SYSTEM.

AC power is supplied by two 60 kva generating systems. See figure 1-10. When operating, the systems are isolated from each other but are synchronized with respect to frequency. Each generator is driven by a constant-speed drive assembly which regulates generator frequency at 400 cycles per second. Voltage regulation and system protective functions are performed by generator control units. A frequency synchronizer controls the right constant-speed drive to keep its output speed in synchronization with the left constant-speed drive. There are three ac buses: a left main ac bus, a right main ac bus, and an essential ac bus. During normal operation, the right generator supplies power to the right main ac bus, and the left generator to the left main ac bus and the essential bus. Each generator is connected to its associated bus with multiple wire generator feeders. Power transfer contactors located near the main ac buses are used to switch the buses from one generator to another. Each main ac bus is normally isolated from the other. The power contactors provide a bus-tie function automatically in the event a generator fails. If a fault or malfunction occurs, causing an undervoltage, overvoltage, underfrequency, or overfrequency condition to exist on a generating system, the associated ac generator control unit removes the generator from the bus. Undervoltage or overvoltage faults result in de-exciting the generator and disconnecting it from the bus. Underfrequency or overfrequency does not cause the generator to de-excite but does cause it to be disconnected from the bus. If a malfunction is corrected, the generator may be reconnected to the bus by properly positioning the generator switches. If a malfunction causing an excessive amount of heat occurs in the constant-speed drive (CSD) unit, a thermal device in the unit automatically decouples the drive from the engine. Once decoupled, the drive cannot be recoupled during flight. An emergency generator with 10 kva capacity provides electrical power to the essential ac bus in the event of failure of both main ac generators. The emergency generator is driven by a hydraulic motor which receives power from the utility hydraulic system. In the event of loss of both primary generating systems, a solenoid-operated valve is de-energized, allowing hydraulic pressure to operate the emergency generator. A pin can be inserted in the valve to prevent emergency generator operation during ground maintenance checks.

AC Electrical Power Supply System

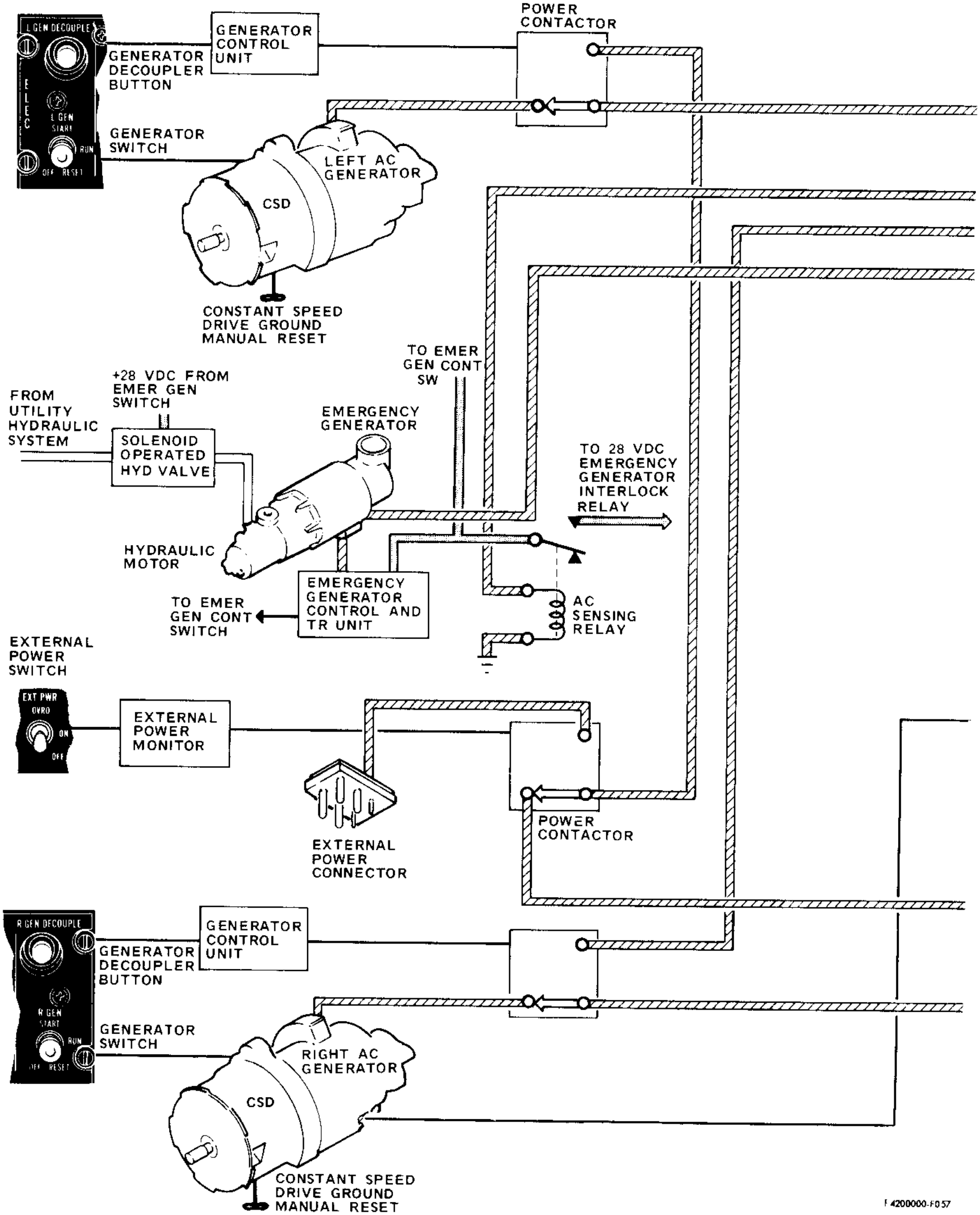


Figure 1-10. (Sheet 1)

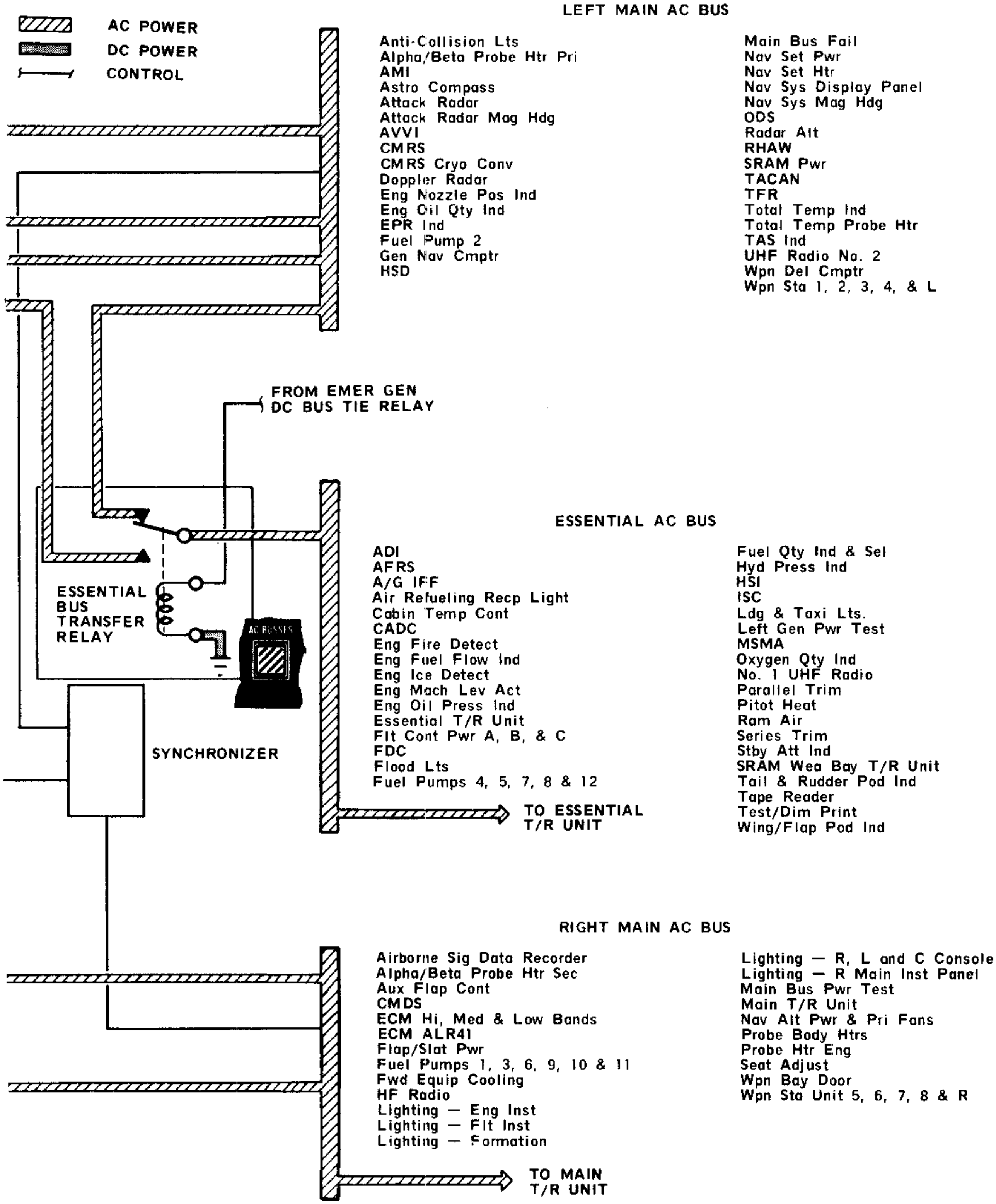


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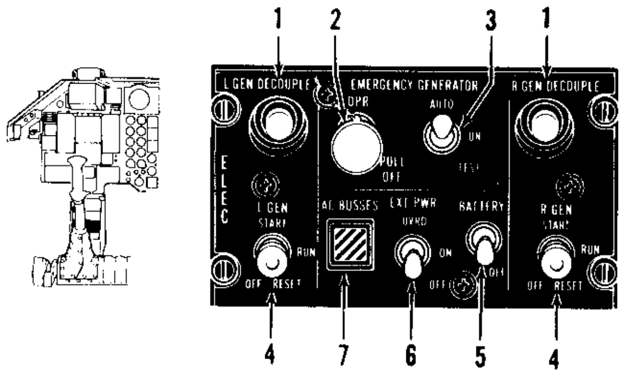
Figure 1-10. (Sheet 2)

Electrical Control Panel



1. Generator Decouple Pushbuttons.
2. Emergency Generator Indicator/Cutoff Pushbutton.
3. Emergency Generator Switch.
4. Generator Switches.
5. Battery Switch.
6. External Power Switch.
7. Electrical Power Flow Indicator.

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Figure 1-11.

Generator Switches.

Two generator switches (4, figure 1-11), located on the electrical control panel are marked OFF-RESET, RUN and START. The switches are lever locked in the OFF-RESET position and are spring-loaded from START to RUN. Placing either switch to OFF-RESET will reset the generator-control unit of the respective generator, but will not excite the generator. Holding the switch to START will excite the generator automatically and connect it to its respective bus. This will be indicated by the power flow indicator and the generator caution lamp will go out. Allowing the switch to return to RUN, after the generator has been connected to its bus, establishes a switching configuration that assures safe operation in the event of a subsequent malfunction. The switch must be positioned to OFF-RESET to allow generator de-coupling.

Note

- If a generator is deexcited while connected to the bus, it will not automatically reset, even though the fault condition is cleared. The switch must be held to OFF-RESET to reset the system.
- If the engine is started with the generator switch in the RUN position the generator will be excited but not connected to the bus until the switch is placed to START.
- There should be a definite pause (approximately 1 second)in the START position before placing the switch to RUN to allow time for power transfer.

Generator Decouple Pushbuttons.

The generator decouple pushbuttons (1, figure 1-11), located on the electrical control panel, are provided to actuate the constant-speed drive decoupler. When a pushbutton is depressed, the constant-speed drive will be decoupled. Once decoupled, the constant-speed drive cannot be reconnected during flight.

Note

The generators cannot be decoupled until the respective switch is positioned to OFF-RESET.

Electrical Power Flow Indicator.

The electrical power flow indicator (7, figure 1-11), located on the electrical control panel, is a flip-flop type indicator labeled AC BUSSES and displays the various bus configurations. If both buses are receiving power from their respective generator, the indicator will display NORM, indicating that the buses are isolated from each other and are operating normally. If only one generator is providing power for both buses, the indicator will display TIE. When the emergency generator is operating and supplying power to the ac essential bus, the indicator will display EMER. When ground power is connected to the aircraft and supplying power to the ac buses, the indicator will display TIE until the right engine is started and its generator comes on the line; then it will indicate NORM. The indicator will display a crosshatched surface if there is no ac power being applied to the aircraft and while the emergency generator switch is in TEST.

Emergency Generator Switch.

The emergency generator switch (3, figure 1-11), located on the electrical control panel, is a toggle switch having positions marked ON, AUTO and TEST. When the switch is in the ON position, the hydraulically driven emergency generator is operating but should not be connected to the essential ac bus unless all ac power is lost. The generator is normally held off the bus by the AC sensing relay, which monitors the left main bus voltage. If the AC sensing relay has failed or all three of the phase sensing circuits are open, the essential ac bus will be transferred to the emergency generator whenever it is operating. With the switch in the AUTO position, if all AC power is lost, the DC bus voltage (main and essential) will be zero; consequently, the solenoid operated valve that controls the flow of hydraulic fluid to the emergency generator drive motor will open. The emergency generator will then automatically begin to operate. When its voltage and frequency are within prescribed limits, the essential bus transfer relay will be energized, thereby transferring the essential ac bus to the emergency generator.

When the switch is in the TEST position, the emergency generator is operating and the emergency generator indicator lamp lights, but the emergency generator is not connected to the essential ac bus if the left main ac bus is powered. If the ac sensing relay has failed, the emergency generator will be connected to the essential ac bus when TEST is selected.

WARNING

Failure of the ac sensing relay will connect the emergency generator to the associated bus when TEST or ON is selected. This failure will be indicated by the flow indicator displaying EMER.

The TEST position also opens the dc bus-tie contactor to provide a method of checking operation of the two transformer rectifier (T/R) units. If the main and essential dc buses remain energized, both T/R units are operating and the electrical power flow indicator will display a crosshatch. When the emergency generator switch is placed in TEST, the essential T/R unit has failed if the landing gear position lamps or the angle-of-attack indexers are out. If the main T/R unit has failed, the ODS reticle will not be lighted and the instrument test will be inoperative.

Emergency Generator Indicator/Cutoff Pushbutton.

The emergency generator indicator/cutoff pushbutton (2, figure 1-11), located on the electrical control panel, provides a means of de-exciting the emergency generator. The pushbutton is marked OPR (operate) and PULL OFF. When the button is depressed, the emergency generator will come on the line and supply power to the aircraft systems whenever both engine-driven generators fail. Should this occur, a green indicator lamp in the button will light. When the emergency generator is supplying power, pulling the button out will de-excite the emergency generator and shut off its power output.

External Power Switch.

The external power switch (6, figure 1-11), located on the electrical control panel, is a toggle switch having positions marked OFF, ON and OVRD. In the OFF position, external power cannot be supplied to the aircraft ac buses. In the ON position with neither engine operating, external power supplies total aircraft power. With the left engine operating, the left main ac generator will supply total aircraft electrical load regardless of whether external power is connected or disconnected. With only the right engine operating, the right main ac generator feeds the right main ac bus and external power feeds the left main ac and essential buses. Associated with the external power is a power monitor which measures external power voltage, frequency, and phase sequence. Should any one of these parameters be out of tolerance, the monitor prevents closing of the external power contactor. When the external power switch is in the OVRD position, the external power monitor circuit is bypassed, thus allowing external power which is out of voltage and frequency tolerance to be applied to aircraft buses. The override position does not override external power with improper phase sequence.

Note

If electromagnetic radiation is experienced while the switch is in the ON position, the power monitor may be affected and reject external power. Power to the aircraft may be regained by placing the switch to OVRD.

Generator Caution Lamps.

Two amber generator caution lamps (figure 1-29) are located on the main caution lamp panel. Either lamp lights when the respective generator is disconnected from the ac bus. When lighted, the letters L GEN are visible in the left lamp and R GEN in the right lamp.

DIRECT CURRENT POWER SUPPLY SYSTEM.

DC electrical power is provided by two 28 volt dc transformer-rectifier (T/R) units and a 24 volt battery. See figure 1-12. There are three dc buses: a main dc bus, an essential dc bus, and an engine start bus. The essential dc bus is divided into two separate buses, one located in the forward equipment bay and one located in the crew module on the aft bulkhead (figure 1-12). The essential buses are electrically connected. During normal operation, the main dc bus section receives power from the main T/R unit, which is connected to the right main ac bus. The essential dc bus, engine start bus and crew compartment power distribution panel receive power from the essential T/R unit, which is connected to the essential ac bus. A bus-tie contactor connects the essential dc bus to the main dc bus during normal operation. Normally the outputs of the two T/R units supply the total dc load in parallel.

Battery Switch.

The battery switch (5, figure 1-11) is located on the electrical control panel. The two-position switch is marked OFF and BATTERY. Positioning the switch to BATTERY connects the engine start bus to the battery. If the essential dc bus is energized, the battery is connected to the main dc bus through the battery charger circuit and the engine start bus is connected to the essential dc bus. When the battery switch is positioned to OFF, the engine start bus is connected to the essential dc bus, and the battery charger circuit is disconnected from the main dc bus.

DC Electrical Power Supply System

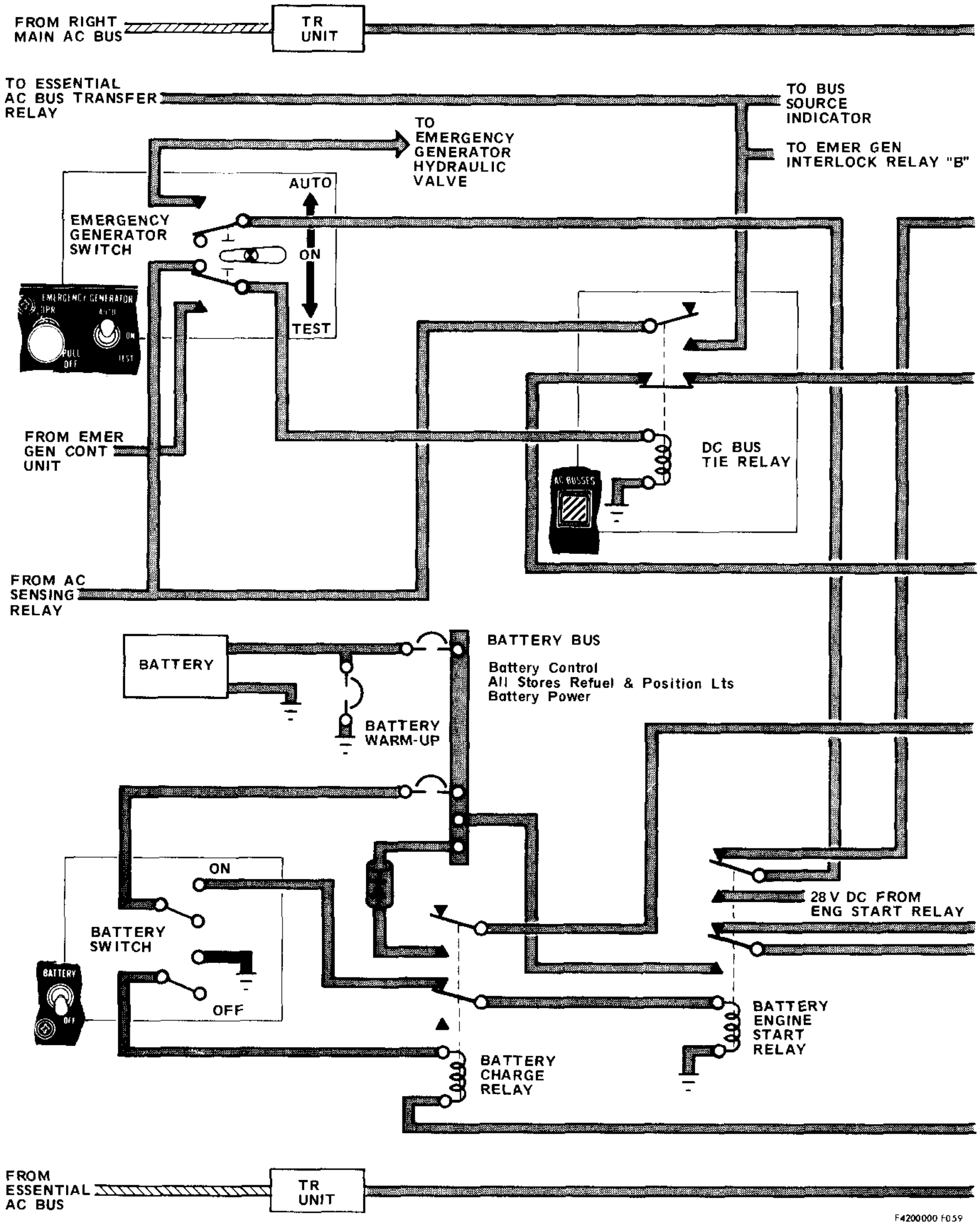


Figure 1-12. (Sheet 1)

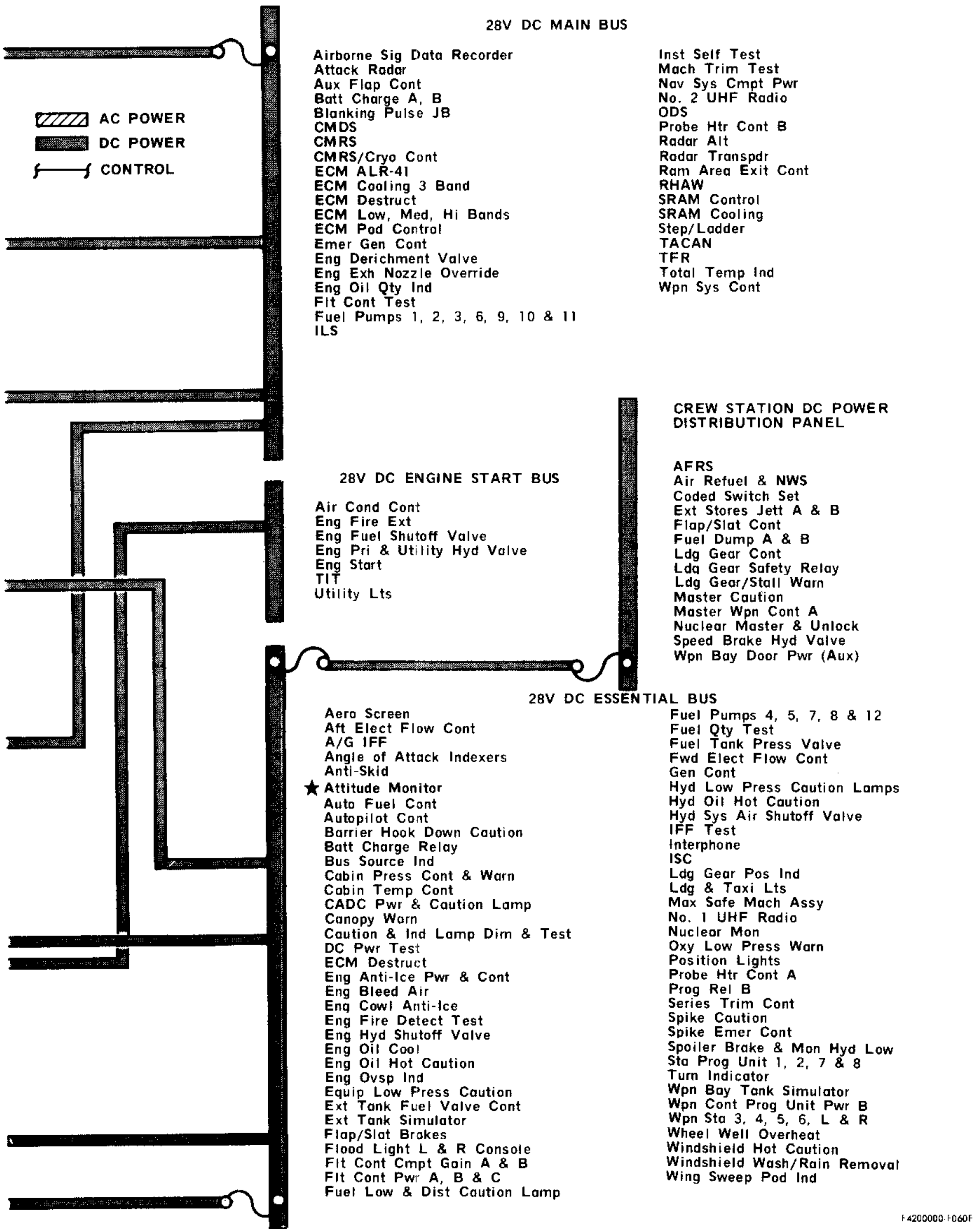
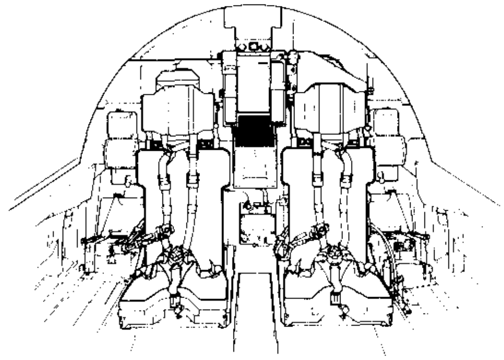
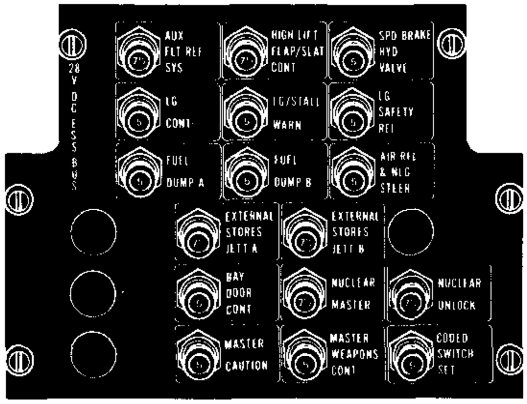


Figure 1-12. (Sheet 2)

Circuit Breaker Panel (Typical)





CIRCUIT BREAKER	EQUIPMENT AFFECTED
AFRS	Loss of power to the primary att and primary hdg caution lamps, the aux att caution lamp and AFRS good signal.
HIGH LIFT FLAP/SLAT CONT	Loss of power to the flap/slat asymmetry system and to the flap/slat emergency motor.
SPEED BRAKE HYD VALVE	Loss of power to the speed brake hydraulic valve.
LG CONT	Loss of power to the extend and retract solenoids on the landing gear hydraulic valve.
LG/STALL WARN	Loss of power to the landing gear handle warning lamp, gear up and lock indicator lamps, stall warning lamp, and to the warning tone generator.
LG SAFETY RELAY	Loss of power to ground safety switches, and to gear handle release.
FUEL DUMP A	Loss of power to fuel dump valves A and C.
FUEL DUMP B	Loss of power to fuel dump valve B, dump relay A & B, and auto transfer valve.
AIR RFL & NLG STEER	Loss of power to air refueling receptacle or nose landing gear steering.

CIRCUIT BREAKER	EQUIPMENT AFFECTED
EXT STORES JET A	Loss of redundant control and power for external stores and pylons jettison.
EXT STORES JET B	Loss of redundant control and power for external stores and pylons jettison.
BAY DOOR CONT	Loss of control power for operation of weapon bay door.
NUCLEAR MASTER	Loss of power and control for the aircraft monitor and control system(AMAC).
NUCLEAR UNLOCK	Loss of power source for nuclear station select, nuclear consent to central program unit station select to B/N, and station select to SRAM.
MASTER CAUTION	Loss of power to the master caution lamp.
MASTER WPNS CONT	Loss of power to delivery mode selector knob, weapon release button, weapons mode selector knob, and essential bus redundant power to central program unit, release program unit, and landing gear up input to central program unit.
CODED SWITCH SET	Loss of nuclear weapon enabling capability.

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Figure 1-13.

HYDRAULIC POWER SUPPLY SYSTEM.

Hydraulic power is supplied by two independent, parallel hydraulic systems designated as the primary and utility systems (figure 1-14). Both systems operate simultaneously to supply hydraulic power for the flight controls and wing sweep. If one or the other system should fail, either system is capable of supplying sufficient reduced power for wing sweep and flight control operation. The primary hydraulic system supplies hydraulic power solely for operation of the wing sweep and flight control systems. In addition to supplying wing sweep and flight control hydraulic power, the utility system also supplies power for operation of:

- Nose wheel steering
- Landing gear
- Wheel brakes
- Speed brake
- Flaps/slats
- Rotating glove
- Weapons bay doors
- Tail bumper
- Emergency electrical generator
- Air inlet (spike) control
- Air refueling system
- Rudder authority

Hydraulic pressure for each system is supplied by two engine-driven, variable delivery pumps. To assure hydraulic pressure in the event of single engine failure, one pump in each system is driven by the right engine, and one pump in each system is driven by the left engine. Pressurized accumulators are installed in the system to supplement engine-driven pump delivery during transient hydraulic power requirements. Each system has a piston-type reservoir for hydraulic fluid storage that also acts as a surge damper for return line pressures. These reservoirs are pressurized with nitrogen to insure critical pump inlet pressure for all operating conditions. Hydraulic pressure of each system is displayed on the left main instrument panel. Low pressure caution lights for each of the four pumps are displayed on the caution light panel. An isolation unit incorporated into the system reserves utility pressure for flight control and wing sweep only, in the event of primary system failure. It also performs a second function of isolating hydraulic pressure after takeoff from those systems normally only associated with takeoff and landing.

HYDRAULIC PUMPS.

Four variable delivery pumps are employed. Normal power for the utility and primary systems is provided by two engine-driven pumps in each system. One pump in each system is driven by each engine. The pumps are each rated at 42.5 gpm, 5800 rpm, and 3100 (±150) psi at 100 percent N2 rpm. Both pumps on the left engine are equipped with electrically-actuated depressurizing valves that are controlled by the left engine start relay. During pneumatic or cartridge starts, these valves depressurize the pumps to reduce engine accessory load until the engine rpm reaches approximately 38 to 41 percent.

Note

After T.O. 1F-111(B)A-650, the electrically-actuated depressurizing valves are deactivated.

HYDRAULIC ACCUMULATORS.

Eight accumulators are provided, five in the utility hydraulic system and three in the primary hydraulic system. Each system has two accumulators for the horizontal stabilizer and one for the damper servos. The utility system has two accumulators for the wheel brake system. See figure 1-80 for servicing data.

HYDRAULIC FLUID RESERVOIRS.

Both utility and primary hydraulic reservoirs are floating piston, pneumatic-oil separated types, using pneumatic pressure on one side of the piston to maintain hydraulic pressure on the other. Pneumatic pressure is supplied from pneumatic storage reservoirs located on the forward end of each hydraulic reservoir and, as an alternate source, from the engine bleed air system. A pressure-operated hydraulic relief valve prevents overpressurization by venting excess fluid overboard when reservoir pressure exceeds 135 psi. Steady-state fluid flow is passed through the reservoir to maintain reservoir warmth and to remove air from the fluid. During high flow rates, the fluid is bypassed around the reservoir and cooler loop directly to the pumps by means of the suction bypass valve. A bypass-type filter is located up-stream of the reservoir. The reservoir also acts as a surge damper for return line impulse pressures. See figure 1-80 for servicing data.

HYDRAULIC COOLING SYSTEM.

Cooling is provided by an air-to-hydraulic heat exchanger and a fuel-hydraulic heat exchanger in each hydraulic system. The controls are arranged so that the cooling medium is air only at low speeds, fuel and air at intermediate speeds, and fuel only at high speeds.

HYDRAULIC ISOLATION VALVE.

An isolation valve is incorporated in the utility system to automatically provide emergency and normal isolation of certain functions of the utility system. In the event of loss of pressure in the primary system, the valve will automatically go into emergency isolation at approximately 500 psi, and cut off all systems except flight controls and wing sweep. It is not possible to manually override the emergency isolation feature. If the primary system pressure increases to approximately 1200 psi, the utility system will automatically

Hydraulic Power Supply System (Utility)

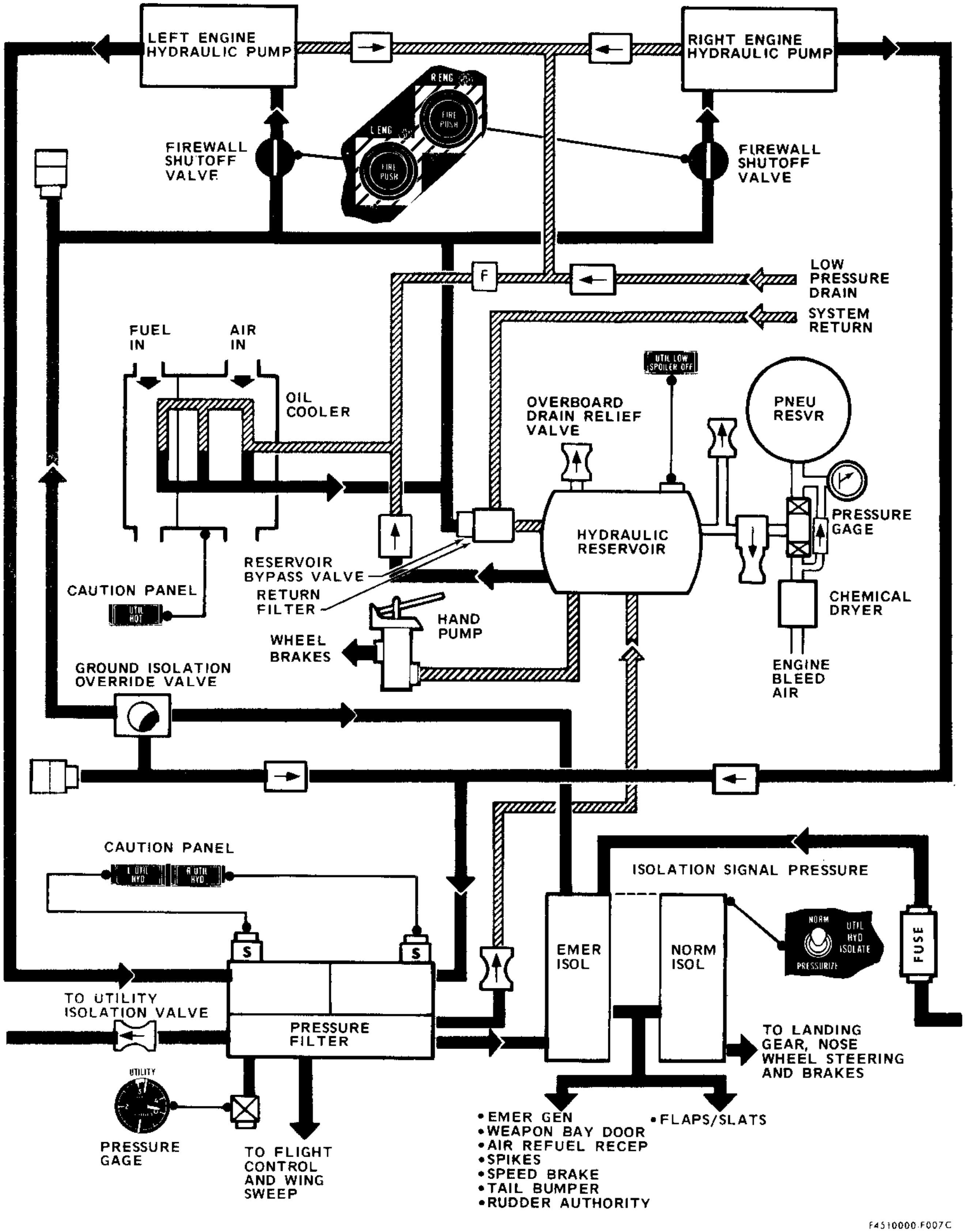


Figure 1-14. (Sheet 1)

Hydraulic Power Supply System (Primary)

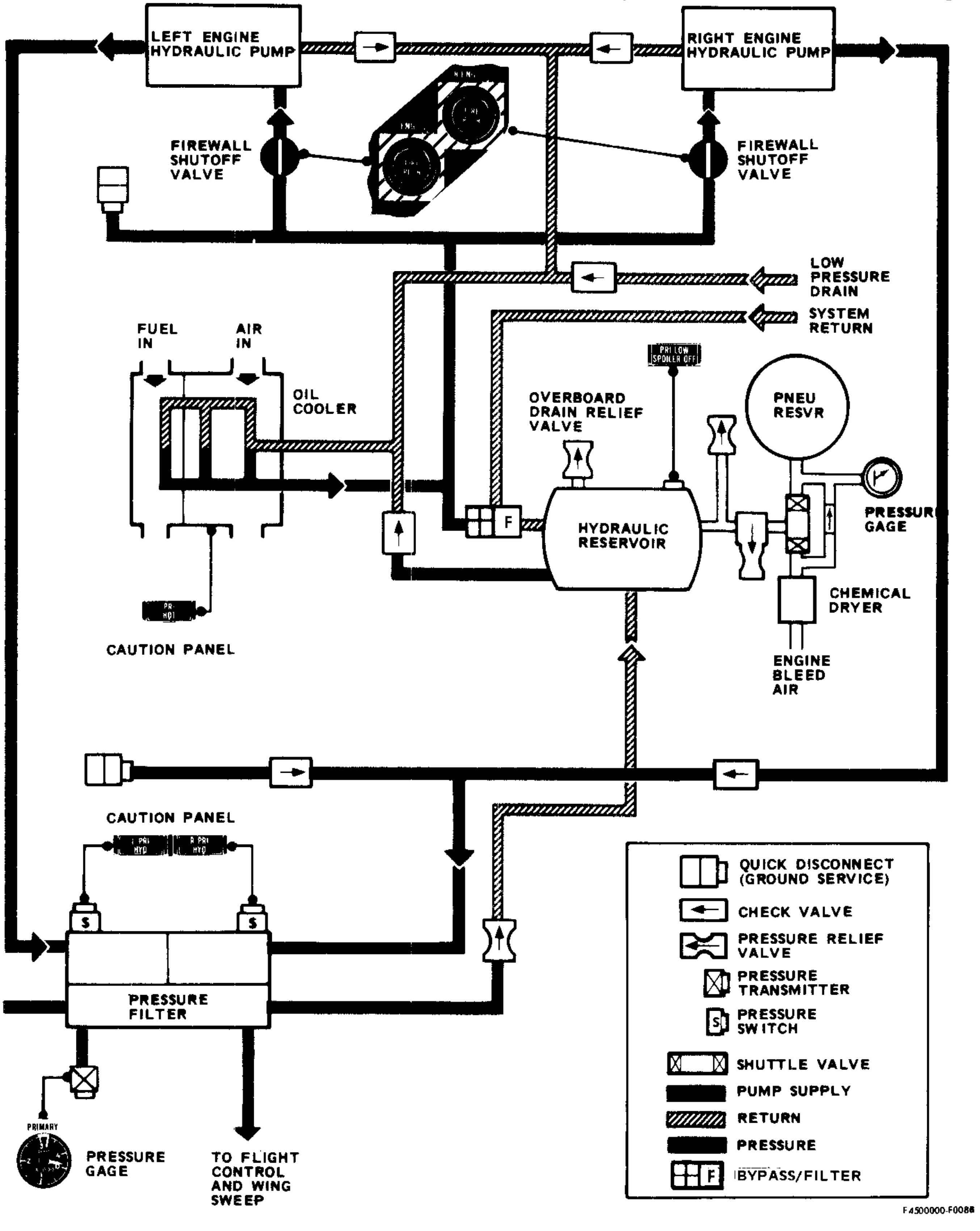


Figure 1-14. (Sheet 2)

be brought out of the emergency isolation. The normal isolation function of the valve is electrically controlled and will isolate the landing gear, wheel brake and nose wheel steering systems when the aircraft is in flight. A separate electrically controlled shutoff valve is included in the flap/slat hydraulic pressure line to provide flap/slat system isolation. The landing gear, wheel brakes and nose wheel steering isolation takes place immediately after the last of all the following three controlling conditions are satisfied:

1. The utility hydraulic isolation override switch is in NORM.
2. The landing gear is up and locked.
3. The flap/slat handle is UP and the flaps and slats are retracted.

Flap/slat isolation is controlled by these same three conditions but the hydraulic shutoff valve is electrically sequenced to provide isolation 30 seconds after the last controlling condition is satisfied. On aircraft 27 ➧ and those modified by T.O. 1F-111-599 the isolation of the landing gear, wheel brakes and nose wheel steering systems is dependent upon controlling conditions 1 and 2 only and flap/slat position will not affect isolation of these systems.

UTILITY HYDRAULIC SYSTEM ISOLATION SWITCH.

The utility hydraulic system isolation switch (7, figure 1-16), with positions marked NORM and PRESSURIZE, is located on the landing gear control panel. The NORM position functions in conjunction with the landing gear and flaps and slats, allowing the following systems to be isolated from the utility system:

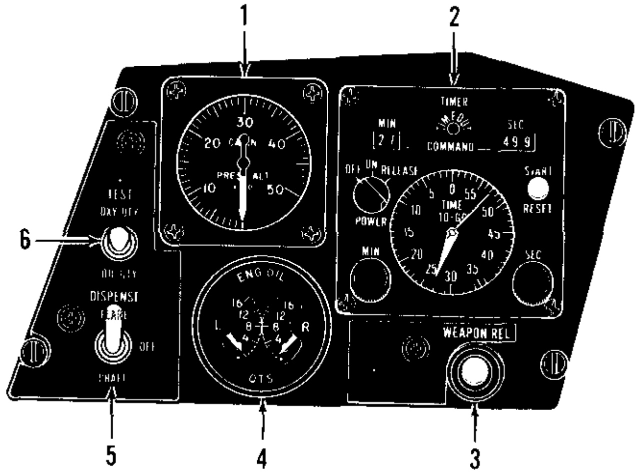
- Landing gear
- Nosewheel steering
- Brakes
- Flaps/slats.

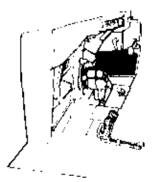
During normal operation positioning the switch to PRESSURIZE supplies utility hydraulic pressure to these systems. If landing gear retraction is initiated with the speed brake switch in any position other than IN, the speed brake may remain fully open or in trail. Placing the hydraulic isolation switch to PRESSURIZE will override the function of the speed brake switches and cause the speed brake to function as a landing gear door and retract. On aircraft 7 ➧ and those modified by T.O. 1F-111-599, the utility hydraulic system isolation switch will not affect flap/slat isolation.

HYDRAULIC FUSE.

A hydraulic fuse is installed on the primary system (sensing) pressure line to system isolation valve. The fuse prevents loss of primary system fluid in event of line rupture by shutting off flow at the downstream port of the fuse.

Auxiliary Gage Panel





1. Cabin Altitude Indicator.
2. Bombing Timer.
3. Weapon Release Button.
4. Oil Quantity Indicator.
5. Flares/Chaff Dispense Switch.
6. Oil/Oxygen Quantity Indicator Test Switch.

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Figure 1-15.

HYDRAULIC SYSTEM PRESSURE INDICATORS.

Two 0-4000 psi pressure indicators, one each for the primary and utility systems, are located on the left main instrument panel (33, figure 1-6). Pressure is measured mechanically and transmitted electrically by pressure transmitters in the system pressure lines. Pressure indication will not occur during engine start if the left engine is started first (either pneumatic or cartridge start) until engine rpm reaches approximately 38 to 41 percent (except aircraft after T.O. 1F-111(B)A-650).

LOW PRESSURE CAUTION LAMPS.

Four amber low pressure caution lamps, energized by pressure switches in each pump pressure line, are located on the main caution lamp panel (figure 1-29). The lamps will light when the individual pump output pressure drops to approximately 400 psi. When lighted, the following letters will be visible in the respective lamp; L PRI HYD, L UTIL HYD, R PRI HYD, and R UTIL HYD. The L PRI HYD and L UTIL HYD lamps will remain lighted during left engine start (either pneumatic or cartridge start) until left engine rpm reaches approximately 38 to 41 percent (except aircraft after T.O. 1F-111(B)A-650).

PRIMARY LOW, UTILITY LOW SPOILER OFF CAUTION LAMP.

These lamps are deactivated.

HYDRAULIC FLUID OVERHEAT CAUTION LAMPS.

Two hydraulic fluid overheat caution lamps, one for each system, are located on the main caution lamp panel (figure 1-29). A lamp lights when the hydraulic fluid temperature of the associated system exceeds 240 ± 10 degrees F (115 ± 6 degrees C). When lighted, the PRI HOT and UTIL HOT letters will be visible in the respective lamp.

PNEUMATIC POWER SUPPLY SYSTEMS.

Independent pneumatic power supply systems provide pressure for emergency operation of landing gear, spike system, and for pressurization of hydraulic reservoirs. Pressure for emergency extension of the landing gear is provided by a pneumatic reservoir located in the main landing gear wheel well. Each spike is provided with a separate pneumatic reservoir located in the main landing gear wheel well. Two pneumatic reservoirs, one for each hydraulic system reservoir, provide pneumatic pressure for hydraulic system operation. For a functional description of each pneumatic system, refer to the associated system descriptions, this section. For servicing information on the pneumatic systems, see figure 1-80.

LANDING GEAR SYSTEM.

The landing gear is tricycle-type, forward retracting, and hydraulically operated. The main landing gear consists of a single common trunnion upon which two wheels are singly mounted. This arrangement of the main landing gear provides symmetrical main landing gear operation. Thermal pressure relief plugs are incorporated in the main landing gear wheels to relieve tire pressure in the event of maximum performance braking. The nose landing gear has two dual-mounted wheels. The landing gear system is normally powered by the utility hydraulic system. A pneumatic system is provided as an alternate (emergency) means of extending the gear in the event the normal system fails. The nose landing gear retracts into the nose wheel well, and the main landing gear retracts into a fuselage well.

MAIN GEAR.

Three hydraulic actuators are provided for operation of the main landing gear. A single-acting linear actuator retracts the main landing gear. Two double-acting linear actuators, one for an uplock and one for a downlock, are provided to lock the landing gear in the retracted or extended position. There are two main landing gear doors. The aft door is mechanically linked to the main landing gear and opens and closes with movement of the gear. The forward door, which also serves as the speed brake, is hydraulically operated. A mechanical connection between the main landing gear and the speed brake selector valve causes the main landing gear door to open and close in the proper sequence during landing gear operation. Ground safety switches, located on the lateral trunnion beam, prevent normal gear retraction while the aircraft is on the ground. See figure 1-17 for location of the ground safety switches.

NOSE GEAR.

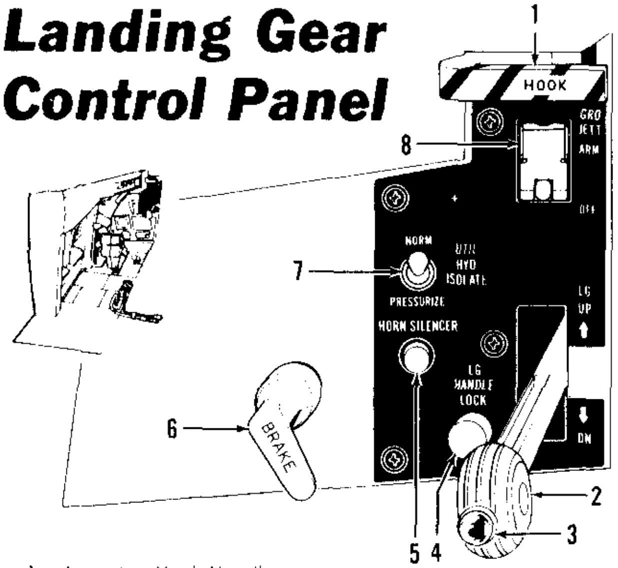
Three hydraulic actuators are provided for operation of the nose landing gear and nose wheel well doors. A single-acting actuator retracts the nose landing gear. An uplock actuator locks the nose landing gear in the retracted position and also, through linkages, opens and closes the two nose wheel well doors. A downlock actuator locks the nose landing gear drag strut when the nose landing gear is extended.

LANDING GEAR CONTROLS AND INDICATORS.

Landing Gear Handle.

The landing gear handle (2, figure 1-16), located on the landing gear control panel, has two positions marked UP and DN. A landing gear warning lamp is located in the landing gear handle. Moving the handle to the

Landing Gear Control Panel



1. Arresting Hook Handle.
2. Landing Gear Handle.
3. Landing Gear Warning Lamp
4. Landing Gear Handle Lock Release Button.
5. Landing Gear Warning Horn Silencer Button.
6. Auxiliary/Parking Brake Handle.
7. Utility Hydraulic System Isolation Switch.
*8. External Stores Ground Jettison Switch.

*See Applicable Weapons Delivery Manual.

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Figure 1-16.

Ground Safety Locks and Safety Pins

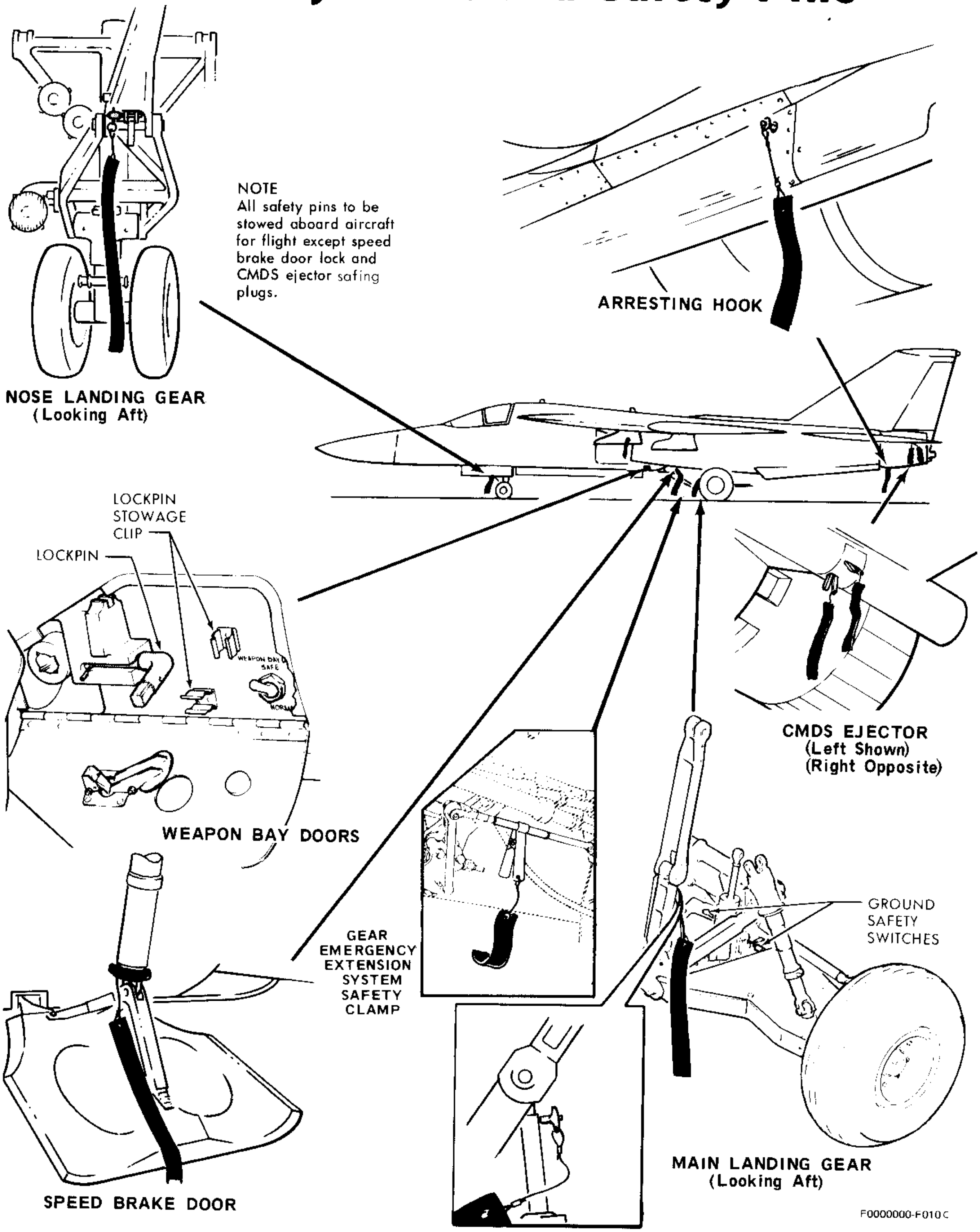


Figure 1-17. (Sheet 1)

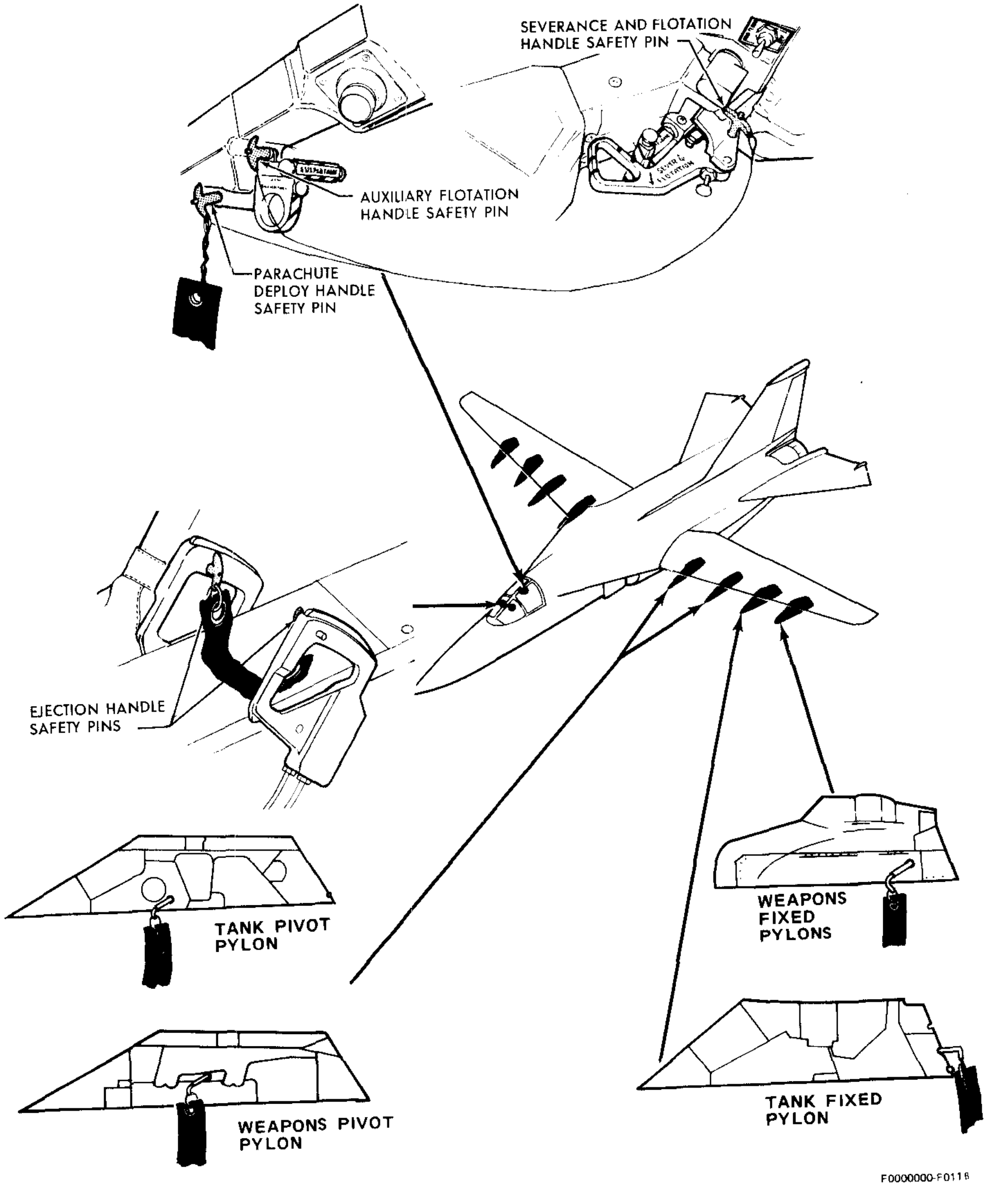


Figure 1-17. (Sheet 2)

UP or DN position will cause the following actions to occur.

Gear Up

When the handle is moved to the UP position, an electrical signal actuates a solenoid-powered landing gear control valve, sending hydraulic pressure to the nose gear downlock actuator, nose gear retract actuator, nose gear uplock door actuator, the speed brake door actuator, and the brake control valve. Hydraulic pressure at approximately 750 psi is metered to one brake circuit to stop main gear wheel rotation. The nose gear unlocks and retracts. When it is almost retracted, it mechanically triggers the nose gear uplatch which then locks the gear up and closes and locks the doors. As the nose wheel doors close, snubbers mounted on the doors engage the tires to stop nose wheel rotation. The main gear forward door (speed brake) actuator extends the door. When the door is sufficiently open to allow the main gear to retract, a linkage from the door opens a valve which sends hydraulic pressure to the main gear downlock actuator, main gear retract actuator, and the uplock actuator. The gear then unlocks and retracts. When it is almost retracted, it mechanically triggers the uplatch which locks the gear up and also actuates a valve to close the speed brake door.

Gear Down

When the handle is moved to the DN position, an electrical signal actuates a solenoid-powered valve, sending hydraulic pressure to the nose gear uplock actuator, nose gear downlock actuator, and the speed brake door actuator. The nose gear uplock actuator unlocks and drives the nose gear doors open and locked, at which time the nose gear is allowed to free fall (extend) against the snubbing of its retract actuator. When the gear is almost extended, the downlock actuator drives it fully extended and locked. The speed brake door actuator opens the door until the door clears the main gear. A linkage then actuates a valve to pressurize the main gear uplock actuator and downlock actuator. The uplock opens, allowing the gear to free fall (extend) against the damping of its retract actuator. When the gear is extended, the downlock actuates. This causes the speed brake door actuator to position the door in the partially retracted (trail) position. The landing gear handle is locked in the DN position by a spring-loaded electrical solenoid when the weight of the aircraft is on the landing gear. Landing gear safety switches control 28 volt dc power to the solenoid. The weight of the aircraft compresses the shock strut and opens the safety switches, which breaks the circuit to the solenoid. When the solenoid is de-energized, the solenoid extends a mechanical lock, holding the landing gear handle in the DN position. Removing the weight from the landing gear closes the safety switches on the landing gear and energizes the solenoid. The energized solenoid retracts the lock and frees the landing gear handle.

Landing Gear Handle Lock Release Button. The landing gear handle lock release button is located on the landing gear control panel (4, figure 1-16). The button must be depressed to release the landing gear handle from the UP position to lower the gear. Normally, it is not necessary to depress the button when retracting the gear since the gear handle is locked in the down position by a solenoid which will release the handle as the weight of the aircraft comes off the gear on takeoff. Should the solenoid malfunction, depressing the button will release the handle to allow gear retraction.

WARNING

> Any time it is necessary to depress the landing gear handle lock release button to move the handle to the UP position, the crewmember should immediately suspect a malfunction of the landing gear ground safety switches. A failure of these switches, which left them in the closed position, would cause all spoilers to remain armed even with the landing gear retracted. If a malfunction of the landing gear safety switches is suspected, place the ground roll spoiler switch to OFF.

Landing Gear Emergency Release Handle.

The landing gear emergency release handle (10, figure 1-31), located on the right main instrument panel, is labeled ALT (alternate) and is provided to extend the landing gear in the event the normal hydraulic system fails. When the handle is pulled, pneumatic pressure is directed to simultaneously open the speed brake door and unlock the nose and main gear uplocks. The gear will free fall to the extended position; then pneumatic pressure will actuate the nose and main gear downlocks and retract the speed brake door to the trail position. Once the gear has been extended by the emergency method, it cannot be retracted. The speed brake door may fail to retract to the trail position. This will be indicated by the landing gear handle warning lamp remaining on after the gear is extended and locked. Should this occur, pushing the handle back in will relieve the pressure in the system and allow the air load to push the speed brake door to the trail position.

CAUTION

> If the handle is pushed in as the aircraft slows down after landing, the weight of the door and lack of air load will cause the door to extend and drag the ground.

Landing Gear Warning Horn.

The landing gear warning horn provides an intermittent audible tone in the headsets when an unsafe landing gear situation exists. The horn sounds intermittent-

ly when the nose and main landing gear are not down and locked and/or the speed brake door is not in trail and all of the following conditions exist:

- Indicated airspeed is below 160 (±12) knots.
- The aircraft is below an altitude of 10,000 (±350) feet.
- One or both throttles are set below minimum cruise setting.

On aircraft modified by T.O. 1F-111-891, the warning horn also provides a steady audible tone in the headsets as a stall warning indication. Refer to "Artificial Stall Warning System," this section.

The malfunction and indicator lamp test button located on the lighting control panel may be used to test the landing gear warning horn. The warning horn may be silenced by depressing the horn silencer button adjacent to the landing gear handle (5, figure 1-16).

Note

On aircraft modified by T.O. 1F-111-891, the stall warning lamp will flash and the rudder pedal shaker will operate as long as the horn silencer button is held depressed.

Landing Gear Position Indicator Lamps.

A plan view silhouette of the aircraft having two green indicator lamps is located on the left main instrument panel (11, figure 1-6). The lamps are positioned to represent the nose and main landing gear. When the landing gear is down and locked, the lamps are lighted. In-transit positions of the landing gear and unsafe landing gear conditions are indicated by lighting of the red warning lamp in the landing gear handle knob. A safe up-and-locked landing gear condition is indicated when both the green indicator lamps and the red warning lamp are off.

TAIL BUMPER SYSTEM.

The tail bumper protects the control surfaces, engines, and portions of the airframe from damage that might occur if the tail inadvertently contacts the ground during ground handling. The tail bumper also provides limited protection during overrotation on takeoff and during landings. In flight, the tail bumper is held in the fully retracted position by hydraulic pressure in the tail bumper lift cylinder. The hydraulic pressure is ported to the tail bumper lift cylinder from the speed brake control valve. When the landing gear is extended and the speed brake returns to trail position, the lift cylinder pressure is relieved and the tail bumper is extended by the pneumatic action of the tail bumper dashpot. The dashpot, which functions as the impact shock absorber, has its own separate reservoir that is charged with compressed nitrogen. Retraction of the landing gear allows hydraulic pressure to again be ported to the tail bumper lift cylinder to retract the bumper and hold it in this position.

Note

The tail bumper may contact the ground if the pitch angle exceeds approximately 11 degrees when the main landing gear is in contact with the runway.

NOSE WHEEL STEERING SYSTEM.

Nose wheel steering provides aircraft directional control during taxiing, takeoff and landing. The system is electrically engaged, hydraulically powered and controlled by the rudder pedals. The nose wheels are positioned by a linear hydraulic actuator controlled by a mechanical rotary servo valve. Rudder pedal movement at either crew station is transmitted to the steering valve by mechanical linkage which includes a cam device on the valve input shaft. The cam device provides a gradually increasing ratio between steering angle and rudder pedal displacement. A relatively larger pedal displacement is required to obtain an increment of steering angle near the neutral rudder pedal position than is required near the full rudder pedal position. Utility hydraulic system pressure supplied to the steering servo valve is controlled by a solenoid operated shutoff valve and a pressure regulator. When steering is engaged, the energized solenoid valve applies full system pressure to achieve a high level steering torque. When steering is disengaged, the pressure regulator supplies approximately 10 percent system pressure for a low level steering torque used to center the nose wheels during retraction. Steering input linkage motion occurring during nose gear retraction automatically centers the nose wheels with up to 50 percent rudder pedal displacement.

CAUTION

If a misaligned/malfunctioning steering system is evident, do not take off unless required and do not retract the landing gear. Nose gear steering alignment can be checked by disengaging the nose wheel steering while taxiing on a level surface. If a steering transient is observed on re-engagement, a misalignment/malfunction is indicated.

Maximum rudder pedal deflection steers the nose wheels 40 degrees either side of center with resultant aircraft turning radius as shown on figure 2-3. Nose

wheel shimmy damping is accomplished by restricting hydraulic flow within the steering valve. If the flaps and slats are retracted, the flight control system switch must be in the T.O. & LAND position or the rudder authority switch must be in the FULL position to allow sufficient rudder pedal movement for full steering authority. The nose wheel steering system is equipped with a limit switch mounted on the nose landing gear shock strut adapter. When nose wheel steering exceeds approximately 40° from center, the switch opens an electrical circuit to the control valve and automatically prevents controlled steering through the rudder pedals. The NWS/AR lamp will go out whenever controlled steering range is exceeded. When nose wheels are returned to normal steering range (0° to 40°), controlled steering automatically reengages. Power for engaging steering is furnished from the essential dc bus.

Note

- Nose wheel steering will not be available if the landing gear is extended using the emergency release handle.
- With the air refuel switch in OPEN and the engine feed selector knob in AUTO or BOTH, nose wheel steering will be operative only while the nose wheel steering/air refuel button is depressed.
- With the engine ground start switch in any position except OFF, nose wheel steering will be operative only while the nose wheel steering/air refuel button is depressed.

NOSE WHEEL STEERING/AIR REFUEL BUTTONS.

A nose wheel steering/air refuel button (3, figure 1-24), is located on each control stick grip. The buttons are labeled NWS and A/R DISC. With the weight of the aircraft on the main landing gear, depressing either button actuates a holding relay to engage the system. The button can then be released, and the system will remain engaged until the button is again depressed and released to open the relay and disengage the system.

Note

- When the nose wheel steering button is depressed and released to disengage the system, a three second delay is initiated. The system may be re-engaged during this period but the holding relay will not be energized.
- During ground operation when the air refueling door is open, the nose wheel steering/air refueling indicator lamp will light to indicate door position and nose wheel steering will function only while the NWS A/R DISC button is held depressed.

The button receives 28 volt dc power from the essential bus. For a description of the A/R DISC function of the buttons refer to "Fuel Supply System", this section.

NOSE WHEEL STEERING/AIR REFUELING INDICATOR LAMP.

A green nose wheel steering/air refueling indicator lamp labeled NWS A/R is located on the left main instrument panel (19, figure 1-6). The lamp will light when the nose wheel steering system is energized or the A/R door is open. For a description of the A/R DISC function of the lamp, refer to "Fuel Supply System", this section. The lamp receives power from the 28 volt dc essential bus.

BRAKE SYSTEM.

Each main landing gear wheel is equipped with a hydraulically operated multiple disc brake. Pressure for operation of the brakes is supplied by the utility hydraulic system for normal operation and by two hydraulic accumulators for power-off braking. Anti-skid control, automatic braking during landing gear retraction, and an auxiliary brake are provided. Normal brake operation is controlled by conventional brake pedals, each mechanically connected to brake metering valves. The brake hydraulic system is a dual-normal type, separated into two circuits. Each circuit operates independently of the other. One circuit operates one-half of the pressure piston on the left brake and one-half the pressure pistons on right brake. The other circuit operates the other half of the pistons on each brake. During normal operation of the brakes, pressure is metered to the brakes from both hydraulic circuits in proportion to applied force on the brake pedals. Full braking effectiveness is achieved with approximately 60 percent of full brake pedal travel. If one hydraulic circuit becomes inoperative, the brake system can provide sufficiently increased pressure to the operative circuit for 90 percent of normal braking effectiveness. This is accomplished by application of greater than normal brake pedal travel and slightly higher pedal force. The dual-normal type brake hydraulic system provides emergency brake operation automatically. Two hydraulic accumulators are provided in the system to supply brake system pressure for normal power off braking due to failure or isolation of the utility hydraulic system. Each accumulator is precharged and supplies pressure to only one of the individual brake circuits. Fully charged accumulators will provide 10-14 full-pressure brake applications or one full-pressure brake application with 32 anti-skid cycles. A priority valve, which limits the quantity of fluid that can be displaced from the brake accumulator through the brake metering valves by actuating the brake pedals, is included in each hydraulic circuit. If the brake accumulators are not replenished as fluid is displaced by

repetitive brake applications or by anti-skid cycling, the priority valves will close when accumulator pressure has been reduced to approximately 1100 (±100) psi. At this pressure all normal braking will be lost and the pedals will be fully depressed.

CAUTION

> Do not actuate the brake pedals in flight when utility hydraulic pressure is isolated from the brake system as there is no way to replenish the brake accumulators. Therefore, if the utility hydraulic system fails or is isolated after the brake accumulators are bled off to below 1100 (±100) psi only emergency braking will be available on landing.

After the priority valves close, the remaining fluid can be utilized only by pulling the auxiliary brake handle; however, this will lock the brakes. No braking action can be achieved by actuating the brake pedals.

AUTOMATIC BRAKING SYSTEM.

The automatic braking system functions to stop wheel rotation after takeoff. When the aircraft has become airborne, moving the gear handle to the UP position will provide hydraulic pressure through the brake control valve at approximately 750 psi to one circuit of the brake system. The hydraulic pressure is applied to one half the pressure pistons in each wheel to stop wheel rotation. The pressure is relieved after the brakes are isolated from the hydraulic system.

ANTI-SKID SYSTEM.

The anti-skid control system provides the following functions:

- Touchdown skid control.
- Proportional skid control.
- Lock wheel skid control.
- Anti-skid failure detection.

Touchdown skid control prevents the brakes from being applied when the weight of the aircraft is off the landing gear and the speed of both wheels is below 20 MPH. Proportional skid control operates throughout the aircraft ground speed range by utilizing wheel deceleration to reduce brake pressure in proportion to a skid tendency. Locked wheel skid control is activated above 20 MPH and causes either brake to be fully released if proportional skid control does not prevent a skid from occurring. Locked wheel skid control would function, for example, should a brake seize or if a wheel is unable to spin-up due to hydroplaning. The failure detection circuit will automatically return the brake system to manual control in the event of an anti-skid malfunction.

Anti-Skid Control Switch.

The anti-skid control switch (2, figure 1-5) is located on the left throttle panel and labeled ANTI-SKID. The switch has two positions, one marked OFF and an unmarked ON (up) position. Placing the switch to ON will provide anti-skid control during normal braking. With the switch in OFF, anti-skid control will not be available and brake pressure will be in direct response to pedal pressure.

Anti-Skid Caution Lamp.

An amber caution lamp labeled ANTI-SKID is located on the main caution lamp panel (figure 1-29). The lamp will light when the anti-skid switch is in the ON position and a malfunction has caused the anti-skid system to become de-energized or when the landing gear is down and the anti-skid switch is not in the ON position.

Note

> When the lamp is lighted, anti-skid control is not available and braking will be in direct response to pedal pressure.

AUXILIARY PARKING BRAKE HANDLE.

The auxiliary parking brake handle (6, figure 1-16), labeled BRAKE, is located on the landing gear control panel. When the handle is pulled out, a mechanical linkage opens a selector valve which admits pressure from the hydraulic accumulators directly into the brake lines downstream of the brake control valve. The primary function of the auxiliary parking brake handle is to apply the brakes while the aircraft is parked. The auxiliary parking brake handle can be used to set the brakes for engine run-up. A secondary function of the auxiliary parking brake is to serve as a supplemental emergency brake in the event that accumulator pressure is reduced sufficiently to cause the priority valves to close and prevent normal brake application by pedal actuation. Brake pressure cannot be metered by the auxiliary parking brake handle. The total accumulator pressure is ported directly to the brake cylinders, bypassing the metering valves and the anti-skid valves. Therefore, the auxiliary parking brake handle should not be pulled while the aircraft is in motion except when braking cannot be achieved by pedal actuation.

CAUTION

> Pulling the auxilary brake handle while the aircraft is moving may cause the wheels to lock if normal brake accumulator pressure is available, and result in tire skidding or blowout, and may result in fire.

BRAKE HYDRAULIC HAND PUMP.

A hydraulic hand pump (figure 1-14), located in the main landing gear wheel well, is provided to replenish brake accumulator pressure during ground handling operation.

AIRCRAFT ARRESTING SYSTEM.

The arresting hook system provides for emergency arrestment of the aircraft. The system consists of an arresting hook, arresting hook dashpot, a dashpot air bottle, an uplock latch, arresting hook controls, a pressure gage, and an air filler valve. Except for the controls, the arresting hook components are located in the lower aft end of the fuselage tail cone.

ARRESTING HOOK HANDLE.

The arresting hook handle (1, figure 1-16), located on the landing gear control panel, is connected to a low friction push-pull type mechanism contained in a flexible metal housing. The handle is labeled HOOK on diagonal stripes. The mechanism provides a direct mechanical linkage from the handle to the arresting hook uplatch mechanism in the tail cone. The arresting hook is released by grasping the handle and pulling aft. The total travel of the handle from retract to extend position is approximately 4 inches. Approximately 1 second is required for the arresting hook to extend. The hook must be raised manually to its stowed position.

ARRESTING HOOK CAUTION LAMP.

The amber arresting hook caution lamp, labeled HOOK DOWN, is located on the main caution lamp panel (figure 1-29). The caution lamp lights to indicate hook down position only.

AERODYNAMIC DECELERATION EQUIPMENT.

Aerodynamic deceleration equipment consists of the speed brake for deceleration in flight and the ground roll spoilers for deceleration after landing. In-flight, sweeping the wings forward is also effective for deceleration. (Refer to "Level Flight Characteristics/ Supersonic Flight", Section VI.)

SPEED BRAKE.

The speed brake, which also serves as the main landing gear forward door, is provided as an aid to deceleration during flight. The speed brake is hydraulically operated and may be used as a speed brake only when the landing gear is up and locked. For operation of the speed brake as a landing gear door refer to "Landing Gear System," this section.

Speed Brake Switches.

A three-position speed brake switch (4, figure 1-5), marked IN, OFF and OUT is located on the right throttle of each crew station. The switches are thumb actuated and slide forward (IN) and aft (OUT). The left crew station switch is detented in all positions. The right crew station switch is spring loaded to OFF from both the IN and OUT positions and will override the left crew station switch. When the right switch is released to OFF, the speed brakes will move to the position selected by the detented left crew station switch. When both switches are positioned to OFF, the speed brake is hydraulically locked in its present position. To maintain a constant load on the landing gear door and to insure minimum drag, the left crew station switch must remain in the IN detent, except during speed brake operation. If the speed brake switch is positioned to OUT or OFF and the landing gear is retracted, the speed brake may remain fully open or retract only to the trail position. The speed brake will retract when the speed brake switch is moved to the IN detent.

GROUND ROLL SPOILERS.

For deceleration during ground roll, the ground roll spoilers are used symmetrically to destroy lift and increase wheel brake effectiveness. In this case, they are armed with the ground roll spoiler switch and activated by the throttle position switches and landing gear squat switches. (Refer to "Aerodynamic Deceleration Equipment," this Section.) Ground roll spoiler operation is not affected by the position of the computer power switches.

Ground Roll Spoiler Switch.

The ground roll spoiler switch (8, figure 1-25), located on the left sidewall, has positions BRAKE and OFF. If the weight of the aircraft is on the landing gear and both throttles are in IDLE, positioning this switch to BRAKE will cause the ground roll spoilers to extend. Under the same conditions placing the switch to OFF will retract the spoilers. With the spoiler switch positioned to BRAKE, if the aircraft weight is removed from the landing gear or if either throttle is advanced out of IDLE, the spoilers will automatically retract.

WING FLAPS AND SLATS.

MAIN WING FLAPS.

The main (wing) flaps are full span, multisection Fowler-type flaps. Each wing flap is divided into six sections. The five outer sections, designated as the main flaps, are mechanically connected and operate as one unit. The main flaps are powered by a single hydraulic motor which is connected to a gearbox located in the fuselage section. The hydraulic motor and gearbox

assembly drive a torque shaft which is connected through gearboxes to mechanical actuators attached to the flaps. An electric motor mounted on this same gearbox provides an emergency mode of operation in the event of either hydraulic system failure. A mechanical interlock control prevents the wing from being swept aft of the 26 degree position with the main flaps extended. The mechanical interlock locks the flap and slat handle in the UP position when either the wing sweep angle is greater than 26½ degrees or when the wing sweep handle is at a position greater than 26½ degrees. Asymmetrical flap travel is monitored by an asymmetry device. When the asymmetry device senses more than 3 degrees asymmetrical flap travel, a signal is sent to close the flap drive control valve and to engage torque shaft brakes which stop travel of the flaps and slats. Once the flap drive control valve has been closed and the torque shaft brakes are engaged by this method, the flaps cannot be extended or retracted by either the normal or emergency mode. Integral with each main flap section is a mechanically controlled vane. As the flap extends downward the vane is positioned by a mechanical linkage to provide the proper airflow through the space between the flap leading edge and the spoiler trailing edge. The main flap hydraulic motor receives pressure from the utility hydraulic system.

AUXILIARY FLAPS.

The inboard section, designated as the auxiliary flap, operates independently from the main flaps by electrical actuators. The auxiliary flap actuators are disabled by electrical interlocks when either the wing sweep angle switch senses more than 16 degrees wing sweep or when the wing sweep handle is at a position greater than 16 degrees. A wing sweep mechanical interlock control prevents the wing from being swept aft of the 26 degree position with the auxiliary flaps up and the main flaps extended. There is no mechanical connection between the auxiliary flaps since there is no necessity to prevent unsymmetrical operation. The auxiliary flap actuators receive 115 volt ac power from the right main ac bus.

WING SLATS.

Each wing is equipped with a leading edge slat. Each slat is divided into five sections which are connected and operate as one unit. The slats operate in conjunction with the main flaps and are connected to the main flap drive assembly by flexible drive shafts. On the extend cycle, the slats will extend to the full down position before the main flaps start to extend. On the retract cycle, the flaps will fully retract before the slats start to retract.

Note

If an asymmetrical slat condition occurs the aircraft will enter a roll in the direction of the extended slat. The initial movement of the flaps will cause the slats and flaps to lock.

ROTATING GLOVES.

The outboard edges of the wing gloves, adjacent to the wing inboard leading edges, are equipped with movable surfaces to allow full forward movement of the inboard slats. These surfaces are called rotating gloves (4, figure 1-1). A door forms the lower surface of each rotating glove. Each rotating glove and its associated door are operated by a mechanical actuator and linkage which is connected to the slat drive flexible shaft. When the slats are extended, the rotating gloves automatically rotate (leading edge down and trailing edge up), and the doors open to allow full extension of the slats.

Flap/Slat Handle.

The flap/slat handle (9, figure 1-5), located on the left throttle panel, has three positions marked UP, SLAT DOWN, and FLAP DOWN. A manually operated gate (8, figure 1-5), located between the SLATS DOWN and FLAP DOWN areas, must be released before the handle can be moved from one area to another. When the handle is moved from UP to any position in the SLAT DOWN area, a mechanical linkage opens the flap drive control valve, directing hydraulic pressure to the flap drive motor. The flap drive assembly rotates the flexible shafts connected to the slat drive mechanism to position the rotating glove and to extend the slats to a position corresponding to handle position. Moving the handle down to the gate will cause the slats to fully extend. When the gate is released and the handle is moved into the FLAP DOWN area, the flap drive assembly will rotate the flexible shafts connected to the main flap actuators, extending the main flaps to a position corresponding to handle position. The flaps can be set at an infinite number of positions between full up and full down. The flap and slat drive assembly is so designed that it will not extend the flaps until the slats are fully extended. Two detent positions are provided in flap handle travel to aid in selecting the 15-degree and 25-degree flap positions. When the handle is moved down to the 25-degree detent, a contact closes and supplies electrical power to the auxiliary flap actuators, causing the auxiliary flaps to extend to 25 degrees. When the handle is moved beyond the 25-degree detent, the main flaps extend, but the auxiliary flaps remain at 25 degrees. The full FLAP DOWN position of the handle provides 37.5 degrees of flap extension or, on aircraft modified by T.O. 1F-111-824,

34 degrees. The retract cycle is the opposite of the extension cycle. When the handle is moved from the full FLAP DOWN position to the UP position, the flaps retract first, followed by the slats. It should be noted that at no time will the flaps extend unless the slats are fully extended, nor will the slats retract until the flaps are fully retracted, regardless of the position of the flap and slat handle. When the handle is moved up to any position less than the 25-degree detent, the auxiliary flaps will fully retract. Normal extension or retraction of the flaps and slats takes approximately 12 seconds.

Note

The handle controls only the auxiliary flaps when the flap/slat system selector switch is in the EMER position.

Flap/Slat System Selector Switch.

The flap/slat system selector switch (14, figure 1-25), located on the left sidewall, has two positions marked EMER and NORM. When the switch is in the NORM position, the flaps and slats are actuated normally by use of the flap handle. When the switch is in EMER, the flaps and slats may be extended or retracted electrically by holding the emergency flap and slat switch to EXTEND or RETRACT, as applicable, and the flap drive control valve is closed, disabling the flap drive motor. The EMER position is used in the event of utility hydraulic system failure.

Emergency Flap and Slat Switch.

The emergency flap and slat switch (15, figure 1-25), located on the left sidewall, has positions marked EXTEND and RETRACT and is spring-loaded to the center unmarked OFF position. The switch is provided as an emergency method of operating the main flaps and slats in the event of a utility hydraulic system failure. Operation of the flaps and slats using this switch is identical to that when using the flap and slat handle except that electrical power is used to operate the flap drive motor instead of hydraulic power.

Note

Emergency flap extension or retraction takes approximately 60 seconds at 180 KIAS. This time will vary with airspeed.

Flap and Slat Position Indicators.

The flap and slat position indicators are a part of the wing sweep, flap/slat position indicator (10, figure 1-6), located on the left main instrument panel. The main flap position indicator provides flap position in degrees. The slat/auxiliary flap indication is a window which provides the following indications:

- UP—Slats and auxiliary flaps retracted.
- SLAT DN—Slats down and auxiliary flaps retracted.
- BOTH DN—Slats and auxiliary flaps full down.
- Crosshatch—Power off or slats or auxiliary flaps in transit.

WING SWEEP SYSTEM.

The variable sweep wings are moved to and held in position by two hydraulic, motor-driven, linear actuators. The actuators are mechanically interconnected to insure positive synchronization (figure 1-18). The left actuator is furnished power by the primary hydraulic system, and the right actuator is furnished power by the utility hydraulic system. In the event of failure of either hydraulic system, the remaining system, by utilizing the load transfer capability of the mechanical interconnect, will still provide wing actuation. However, actuation under this condition will be at a reduced rate commensurate with actuator loading. Wing position is controlled by a closed loop mechanical servo system in response to an input signal from the wing sweep handle. The maximum rate at which the wings extend or retract is controlled by flow-limiting devices in the hydraulic lines. Directional reversal, due to aerodynamic loads, is prevented by the nonreversing threads in the actuator. A mechanical interlock prevents the wing sweep handle from being moved past the 26½ degree position when either the flap and slat handle is out of the UP position or the main flaps are out of the fully retracted position. The wing sweep handle is locked in the 16 degree position by a solenoid operated latch whenever the auxiliary flaps are out of the zero position. Should total electrical power be removed, the solenoid-operated latch would be inoperative and wing position would lock at 16 degrees if the wing sweep control handle were positioned fully forward. For wing sweep limits with external stores, refer to Section V.

WING SWEEP HANDLE.

The wing sweep handle (12, figure 1-25) is shaped like a pistol grip and is spring-loaded to a stowed position under the canopy sill on the left side of the crew module. Teeth in the top of the handle lock it to serrations in the handle support when it is stowed, to prevent inadvertent movement. To adjust wing sweep, the handle must be rotated to the vertical position to unlock it; then it can be moved forward or aft as necessary. The handle is mechanically linked to the wing sweep control valve. The handle is pulled aft to sweep the wings aft and pushed forward to

Wing Sweep and Pylon System

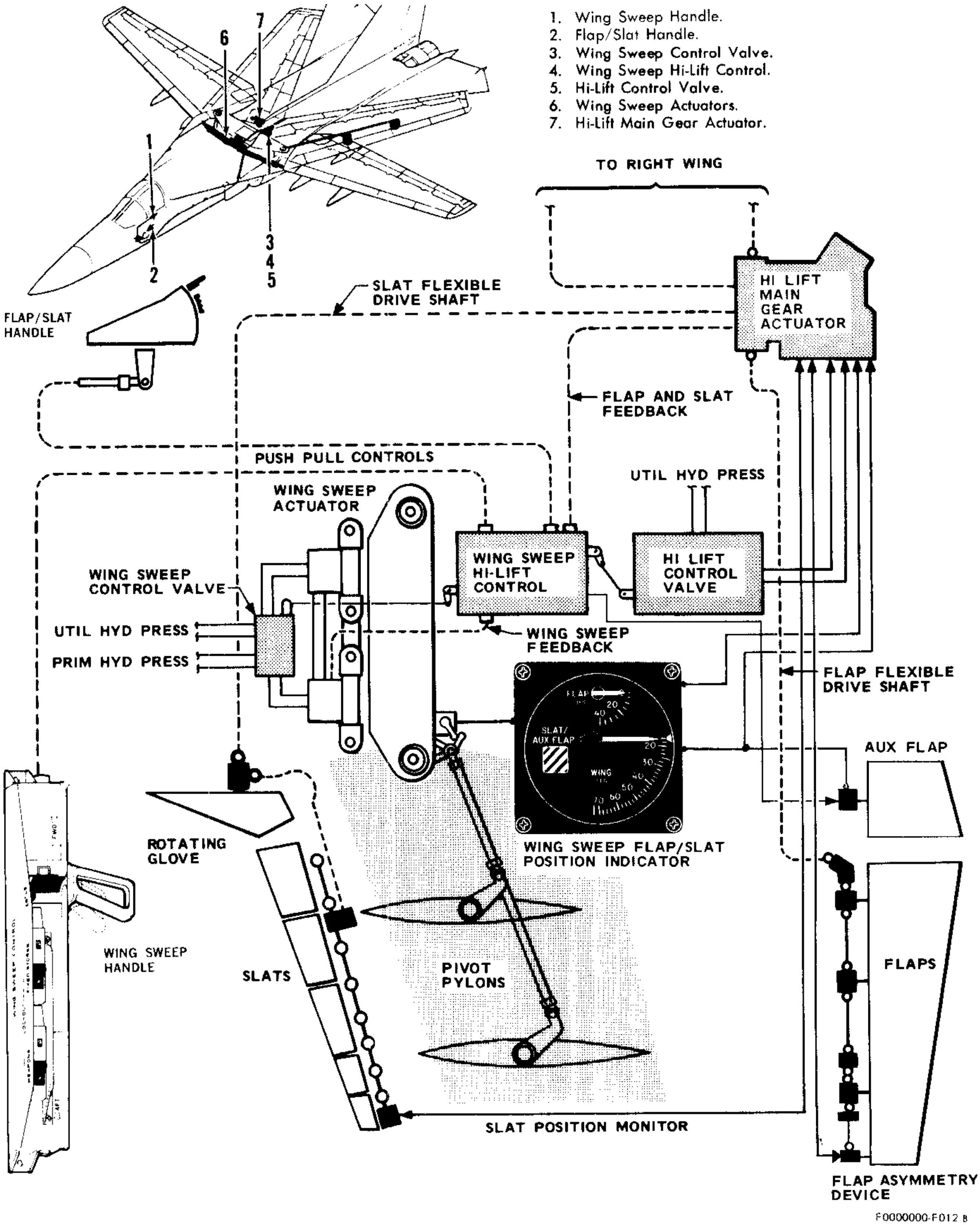


Figure 1-18.

sweep the wings forward. As the handle is moved, an index marker on the wing sweep position indicator follows the handle position to assist in selecting the desired wing sweep position.

WING SWEEP HANDLE LOCKOUT CONTROLS.

Two wing sweep handle lockout controls (10, figure 1-25), one labeled FIXED STORES and the other labeled WEAPONS, are located just above and aft of the wing sweep control handle. When either control is moved forward, the word ON is visible, and a latch extends which prevents aft movement of the wing sweep handle past the latch. When either control is moved aft, the word OFF is visible and the latch retracts. The fixed stores lockout control, when ON, prevents the wing sweep handle from being moved aft past the 26 degree position. This is the sweep angle at which the fixed pylons and stores are in a streamlined configuration. The weapons lockout control restricts aft movement of the wing sweep handle to 54 degrees. This is the wing sweep angle past which certain weapons on the inboard pivot pylons would strike the fuselage. The wing sweep handle lockout controls restrict aft movement of the wing sweep handle only. Forward motion is unrestricted between 72.5 and 26 degrees.

WING SWEEP HANDLE 26 DEGREE FORWARD GATE.

A wing sweep handle 26 degree forward gate (11, figure 1-25), located above the wing sweep handle, is provided to stop forward motion of the wing sweep handle at 26 degrees. The gate is thumb-actuated and is spring-loaded to the latched position. Depressing the gate will retract a latch, allowing the wing sweep handle to be moved forward past the 26 degree position.

WING SWEEP POSITION INDICATOR.

The wing sweep position indicator (10, figure 1-6) is a part of the wing sweep, flap/slat position indicator located on the left main instrument panel. The indicator displays the wing position in degrees and is graduated in 2 degree increments from 16 to 72 degrees. An index mark at 26 degrees provides a reference for selecting this position. Selected wing sweep angle is indicated by a reference index marker on the outside of the scale. The actual angle of wing sweep is monitored by a transmitter which mechanically follows the change in wing position and converts this information to an electrical signal which drives the wing sweep indicator pointer. The indicator receives power from the 28 vdc essential bus.

FLIGHT CONTROL SYSTEM.

The primary flight control system provides control of the aircraft by movement of the primary control surfaces. The primary control surfaces consist of a rudder, spoilers on each wing and movable horizontal stabilizers. Pitch attitude of the aircraft is controlled by symmetrical deflection of the horizontal stabilizer surfaces. Roll attitude is controlled by asymmetrical deflection of the horizontal stabilizer surfaces; and when the wing sweep angle is less than 45 degrees, roll control is aided by action of two spoilers on top of each wing. Yaw control of the aircraft is accomplished by deflection of a rudder surface located on the trailing edge of the vertical stabilizer. Hydraulic servo actuators are used to produce control surface movement. The control stick at each crew station is mechanically and electrically interconnected with the flight control system. The right stick may be removed for various mission requirements. This must be accomplished while the aircraft is on the ground. When the right stick has been removed, an electrical plug is inserted in place of the stick to maintain electrical continuity. The two sets of rudder pedals are mechanically linked together. A system of push-pull tubes, bell cranks, and pulleys are used to connect the cockpit controls with the rudder and horizontal stabilizer hydraulic actuators. The linkage connections are secured with self-retaining bolts, which use self-locking cotter keyed nuts. Loss of the cotter key and self-locking nut will not cause separation of the connection. The stability augmentation system employs redundant sensors, electronic circuitry and electro-hydraulic dampers. The three damper actuators, the horizontal stabilizer actuators, and the rudder actuator are supplied by both primary and utility hydraulic systems and can operate on either system should one system fail. The pitch and roll damper response (gain) is varied by a self-adaptive system as flight conditions change. Command augmentation, through the pitch and roll dampers, augments the pilot inputs to provide a near constant relationship between control force and aircraft response throughout the operational envelope. Automatic failure detection and rejection, as well as self-test features, are provided in the pitch, roll, and yaw stability augmentation systems. Should electrical power be absent from one or more of the redundant computers, the applicable channel caution lamp will light. Power to all computers is controlled from the three computer power switches located on the ground check panel. The pitch and roll damper systems accept inputs from the CADC and the navigation system to provide pitch and roll autopilot modes. The flight control system functions in conjunction with the terrain following radar (TFR) through the pitch damper to maintain the aircraft at a preselected altitude above the terrain.

PITCH CHANNEL.

Mechanical Linkage.

Manual control of the aircraft in pitch is achieved by fore and aft movement of the control stick. This movement is transmitted along the pitch channel push-pull tubes and bellcranks to the left and right horizontal stabilizer actuator control valves. These control valves control the flow of hydraulic fluid to the actuators, thus causing the horizontal stabilizers to move symmetrically. Figure 1-19 is a simplified schematic of the mechanical flight control linkage. Control stick centering and feel forces are provided by the pitch feel spring.

Parallel Trim Actuator.

The parallel trim actuator will cause displacement of the horizontal stabilizers and will also cause displacement of the control stick unless the stick is manually restrained.

Series Trim Actuator.

The series trim actuator output is added downstream of the pitch feel spring. Displacement of this actuator will cause the horizontal stabilizers to displace, but it will not normally cause displacement of the control stick. Likewise, displacement of the pitch damper servo will cause the horizontal stabilizers to displace but will not normally cause displacement of the control stick.

Control Stick Movement.

Control stick displacement can occur due to series trim actuator or pitch damper displacements if, for some reason, their action can not cause displacement of the pitch command output rod shown in figure 1-19. (Refer to "Stick Talk Back", this section.) Control stick stops are provided in the crew module to limit the available stick motion.

Pitch Command Limits.

Pitch commands to the pitch/roll mixer are limited by the pitch mixer stops. The following table summarizes these stop limits and the limits of the other components just described. In all cases, the values listed are in degrees of horizontal stabilizer deflection assuming all the other inputs are zero.

INPUT	NOSE UP LIMIT	NOSE DOWN LIMIT
Control stick stop	22 degrees	14 degrees
Pitch mixer stop	25 degrees	15 degrees
Parallel trim actuator	10 degrees	8 degrees
Series trim actuator	10 degrees	4 degrees
Pitch damper servo	13 degrees	13 degrees

With both trim actuators at zero and the pitch damper at zero and OFF, total stick travel from neutral to full aft is approximately 6½ inches, and from neutral to full forward is approximately 4 inches. The force required to move the stick from neutral to full aft ranges from the initial breakout force of 1.7 pounds to 65 pounds. The force required to move the stick from neutral to full forward ranges from 1.7 pounds to 55 pounds. When takeoff trim is set, the parallel trim actuator drives to a zero degree surface command, and the series trim actuator will drive to position both horizontal stabilizers to 3.8 degrees trailing edge up. With the pitch damper on, control stick displacement or parallel trim actuator displacement will cause the pitch damper to displace in response to signals from the pitch stick transducer. (Refer to "Pitch Command Augmentation," this section.)

Power Supply.

Power to the pitch damper servo, series trim actuator, parallel trim actuator, and stick transducer is controlled from the three computer power switches on the ground check panel. When these switches are turned OFF, the pitch damper actuator is hydraulically driven to its zero position and the series and parallel trim actuators will stop. If hydraulic pressure is not available, the position of the pitch damper servo is indeterminate.

Pitch/Roll Mixing.

Combined pitch and roll movements of the control stick are transmitted by the linkage of their respective channel to the pitch/roll mixer assembly. In this assembly the pitch/roll commands are summed mechanically and converted into left and right horizontal stabilizer actuator command signals. (See figure 1-19.)

Mixer Outputs.

The output of the pitch roll mixer is transmitted by two push-pull tubes. The left push-pull tube causes displacement of the control valve located on the left horizontal stabilizer actuator. When the control valve is displaced from neutral, hydraulic fluid is ported to the left-hand horizontal stabilizer actuator, which results in horizontal stabilizer displacement. The right push-pull tube moves the control valve on the right horizontal stabilizer actuator in a similar fashion. Deflection of the left and right horizontal stabilizers is limited by the horizontal stabilizer actuator ram stroke. The nominal nose up limit is 30 degrees and the nose down limit is 15 degrees.

Pitch Trim System.

Pitch trim can be effected from one of three inputs. These inputs are parallel pitch trim, series pitch trim, and auxiliary pitch trim through the pitch damper servo. Parallel pitch trim allows the pilot to change

Pitch and Roll Mechanical Schematic

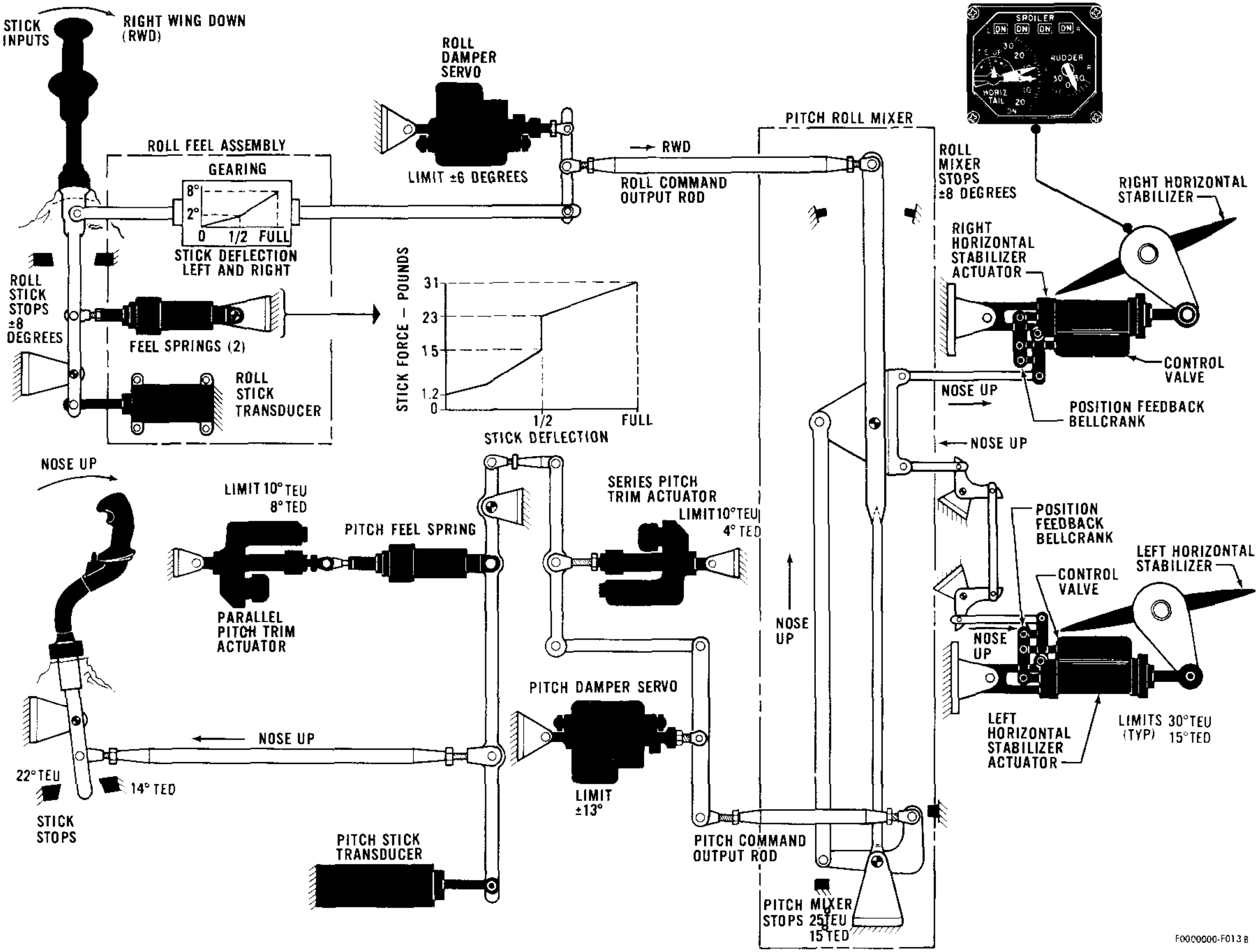


Figure 1-19.

the stick neutral point and is the prime trim mode in the takeoff and landing configuration. Also it may be used as a supplemental trim when the flight control system is in normal. Series pitch trim is provided to carry the elevator required for trim and serves to minimize steady state errors during autopilot modes and auto TF operation. An auxiliary pitch trim system, utilizing the series trim actuator and pitch computer, is provided as a backup trim system and to be used if a trim failure occurs. The operation of each trim input is determined by (a) the auxiliary trim switch position, (b) the pitch damper switch position, and (c) the control system configuration as determined by the slat position and the control system switch. Figure 1-20 summarizes the trim system as a function of these variables.

Parallel Pitch Trim. Parallel pitch trim is the prime trim mode in the takeoff and landing configuration. It may also be used as supplemental trim when the flight control system is in normal. During normal operation, parallel trim will be at neutral for one "g" flight. The parallel pitch trim actuator is driven from the control stick(s) trim button only if the pitch damper switch is in DAMPER and the auxiliary pitch trim switch is in STICK. The parallel pitch trim actuator can also be commanded to drive by one of the following means:

- By depressing the takeoff trim button which centers the parallel trim actuators at the takeoff position (zero degrees).
- By turning the pitch damper switch to OFF which centers and locks parallel trim at takeoff position (zero degrees).
- By moving the auxiliary pitch trim switch out of the STICK position which centers and locks parallel trim at takeoff position (zero degrees).
- By placing the pitch autopilot/damper switch to AUTOPILOT or placing the auto TF switch to AUTO TF, which centers and locks parallel trim at takeoff position (zero degrees).

The parallel trim actuator, when trimmed, will cause the control stick, pitch damper, and horizontal stabilizers to displace. The control stick will be centered and the pitch trim function of the stick trim button is disabled when pitch autopilot is selected, auto TF is selected, and during TFR fail safe flyup maneuvers.

Series Pitch Trim (Autotrim). The series pitch trim actuator drives the horizontal stabilizers but does not *normally drive the control stick. The actuator is locked* at its present position when the control system is switched to the takeoff and land configuration. The takeoff and landing configuration is established by either placing the control system switch to T.O. & LAND or by extension of the slats. The series trim is driven to its 5.8-degrees trailing edge up position when the takeoff trim button is depressed. While the control system is in its normal flight configuration the series pitch trim will act to maintain the aircraft's normal acceleration at a value proportional to stick position. This is accomplished by the series *trim* driving in response to a pitch damper position signal. When the pitch damper is at zero the series trim will stop driving. This is called the null mode of operation. The null mode will be in effect unless the pitch damper is turned off or takeoff and land configuration is established. If the pitch damper is turned off, series trim will lock at its present position, and it can then be driven from the control stick trim button(s). The authority of the series pitch trim actuator is 10 degrees trailing edge up and 4 degrees trailing edge down. The *actuator is rate limited at 1.4 degrees per second.* Displacement of the control stick by force or by trim will command an increase or decrease in normal acceleration through the command augmentation feature. Changes in the elevator required to hold the aircraft in the one "g" flight condition while the stick is at neutral are provided by the pitch series trim. The pitch series trim is driven from the pitch damper position transducer. If the pitch damper inputs are zero, i.e., no pitch rate and one "g" normal acceleration, and the stick is at neutral, then the pitch damper will *be at zero, and the series trim actuator will stop.* If the elevator required to hold the aircraft at this condition varies due to power or wing sweep changes, then the damper will displace to oppose aircraft rotation. This will cause the series trim to drive until the damper inputs again become zero. Thus the series trim system provides the steady state elevator required to maintain the aircraft in trim. Because of this action, the stick will be at the same position for one "g" flight regardless of speed, unless the control system is in the T.O. & LAND configuration.

Note

During ground operation, series trim is not able to null the damper since there is no aircraft response. This will result in trim drift either nose up or nose down while the slats are retracted and the control system switch is in NORMAL.

Auxiliary Pitch Trim. The auxiliary pitch trim system is armed when the auxiliary pitch trim switch is placed to the center (OFF) position. When the switch is placed to the NOSE UP or NOSE DOWN position, pitch trim is provided by one or both of the following:

(1) Positioning an auxiliary pitch trim integrator in the feel and trim assembly, which sends command signals to the pitch damper.

(2) By directly driving the pitch series trim actuator.

The net effect is a change to the aircraft pitch trim. Figure 1-20 defines whether (1), (2), or both is used as a function of the flight control systems configuration.

Flight Control System Configuration vs Pitch Trim Operation

PITCH TRIM DURING MANUAL CONTROL MODES

FLIGHT CONTROL SYSTEM CONFIGURATION			*PITCH TRIM OPERATION*
Auxiliary Pitch Trim Switch	*Autopilot Damper Switch*	**Flight Configuration*	
STICK	DAMPER	Clean	1. Stick trim drives parallel pitch trim. 2. Series trim actuator in damper null mode.
STICK	DAMPER	Takeoff & Land	1. Stick trim drives parallel pitch trim. 2. Series trim locked at existing position.
STICK	OFF	Clean or Takeoff & Land	1. Parallel pitch trim actuator centers and locks at zero. 2. Stick trim drives series pitch trim actuator.
OFF	OFF	Clean or Takeoff & Land	1. Parallel pitch trim actuator centers and locks at zero. 2. Series trim actuator may be driven from the stick trim switch or the auxiliary pitch trim switch.
OFF	DAMPER	Clean	1. Parallel pitch trim actuator centers and locks at zero. 2. Series pitch trim actuator in damper null mode. 3. Auxiliary pitch trim switch drives damper.
OFF	DAMPER	Takeoff & Land	1. Parallel pitch trim actuator centers and locks at zero. 2. Auxiliary pitch trim switch drives damper and also drives the series pitch trim actuator.

*Flight Configuration:

Clean: Flight control system switch—NORM and slats up

T.O. & L: (1)Flight control system switch—NORM and slats-down or
(2) Flight control system switch—T.O. & LAND

PITCH TRIM DURING AUTOMATIC CONTROL MODES

MODE	*PITCH TRIM OPERATION*
AUTO TF	1. Stick trim deactivated and parallel pitch trim actuator centers. 2. Auxiliary pitch trim switch must not be used in this mode. 3. Series pitch trim actuator is driven by Auto TF climb/dive error.
PITCH AUTOPILOT MODES	1. Stick trim deactivated and parallel pitch trim actuator centers. 2. Auxiliary pitch trim switch must not be used in these modes. 3. Series pitch trim is driven by pitch autopilot error signal.

Figure 1-20.

WARNING

Improper operation will result if the auxiliary pitch trim switch is operated during auto TF or pitch autopilot modes.

The authority of the auxiliary pitch trim integrator command to the pitch computer will be a function of the pitch computer gain.

Stability Augmentation.

Pitch stability augmentation is provided through the redundant pitch damper system to provide aircraft damping and to improve the handling characteristics of the aircraft. (Refer to "Pitch Channel Redundancy," this section.) Figure 1-21 shows the basic mechanical system and the pitch damper system. The pitch computer provides damping signals to the pitch damper servo in response to normal acceleration and pitch rate feed back signals from the accelerometers and gyros. The stick position transducer signals are zero when the control stick is at neutral, thus providing a zero command signal to the pitch computer. Series trim will provide the steady state elevator to maintain the aircraft in trim; the normal accelerometer and pitch rate gyro signals will provide damping, and the aircraft will be in one "g" flight.

Command Augmentation.

The effectiveness of any control surface varies with the flight conditions. At low speed and high altitude several degrees of elevator are required to command a one "g" maneuver while at high speed and low altitude it may take less than a degree. With the pitch damper off, stick force and surface movement are directly related to stick motion; thus heavy stick forces will be required at low speed and light forces will be required during high speed, low altitude flight. With the pitch damper on, the stability augmentation feature, sensing pitch rate and normal acceleration, may oppose the initial aircraft response. However, when the stick is moved to command "g's" the stick input to the elevator is augmented by the pitch damper so that for practically any flight condition (high speed or low speed, at all altitudes) "g" response will be about the same for a given stick force. The command augmentation feature accomplishes this by adding elevator, if it is needed, to get the aircraft started on its pitch change, then as it approaches the commanded "g's," the damper and series trim will move the elevator so that aircraft response zeros out on the commanded "g." At low airspeed where control effectiveness is low, the damper will work to give the higher elevator deflection needed to reach commanded "g's." As airspeed increases, less deflection is required and the system works the damper to result in less deflection for the same stick movement. Under steady state conditions, the series trim is driven by the out-of-neutral damper signal. This has two simultaneous effects: the series trim action provides the final input to achieve the commanded response and also nulls the damper, allowing full authority to be restored. Basically the command augmentation system changes the elevator deflection so that the airplane response to stick inputs is the same regardless of airspeed or altitude.

WARNING

The command augmentation feature of the flight control system will attempt to maintain the stick-command level of pitch rate, "g" force, and roll rate independent of airspeed variations. For instance, during flight conditions where airspeed is decreasing, the horizontal stabilizer will be commanded to increase angle-of-attack, without additional pilot input, in an attempt to maintain the commanded level of pitch rate, roll rate, and "g" force. Failure to monitor and control angle-of-attack within limits can result in inadvertent rapid departure from controlled flight.

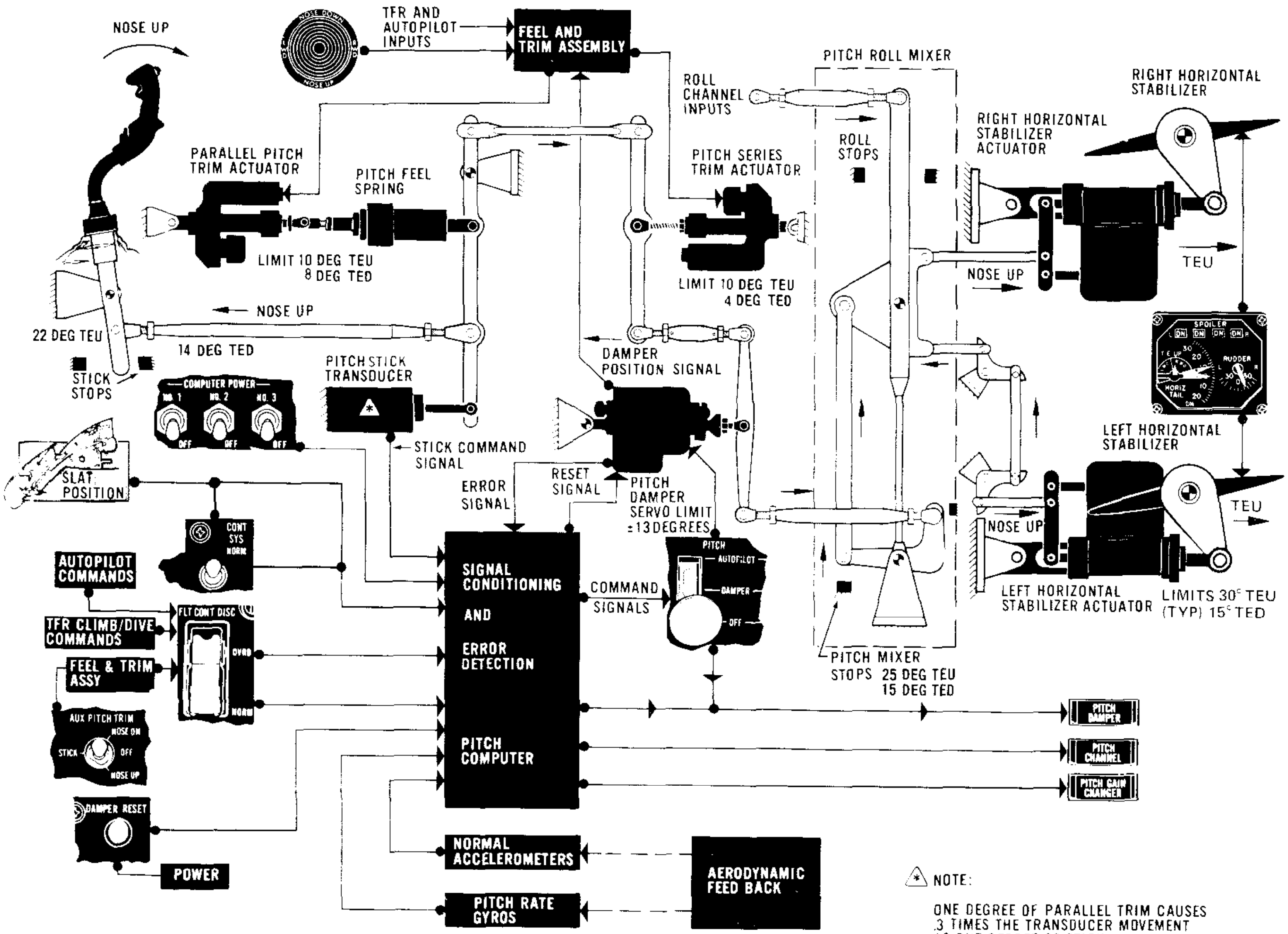
Automatic Pitch Control.

The pitch computer can also accept inputs from either the autopilot pitch submodes or the TFR computer to provide automatic pitch control through the pitch damper. Refer to figure 1-21. Interlocks are provided to prevent incompatible mode selection. Refer to Autopilot and TFR this Section.

Pitch Gain Control.

The gain of the command signal sent to the pitch damper servo is automatically varied as flight conditions change. This is accomplished by continuously monitoring the pitch rate gyro and normal acceleration signals to determine if the gain should be either increased or decreased. Since the system modifies its gain as a function of its own performance, it is called a self-adaptive gain system. In general the required gain varies inversely with dynamic pressure. Elevator effectiveness is affected by many variables such as mach number, altitude, wing sweep angle, gross weight, center-of-gravity, and external stores. The damper contributions in response to command augmentation inputs are a function of gain, therefore, a gain increase will compensate for reduced elevator effectiveness by giving more elevator for the same command, thereby holding the aircraft response and damping nearly con-

Pitch Channel Electrical Schematic



NOTE:

ONE DEGREE OF PARALLEL TRIM CAUSES .3 TIMES THE TRANSDUCER MOVEMENT AS ONE DEGREE OF STICK

F0000000.F014 B

stant. If the available gain is too low, the aircraft response will appear sluggish to stick commands. If the gain becomes too high, a small amplitude pitch oscillation may exist for a few cycles until the gain control circuit, which senses this oscillatory condition, reduces the gain to the proper value. The frequency of this oscillation (the adaptive frequency) will be between 1.4 to 3.0 cycles per second; the gain changer is designed to either increase or decrease the gain for this range of input frequencies depending on their amplitude and persistence. Also, the gain changer will increase the gain for inputs less than 1.4 cps. Rapidly changing flight conditions can result in the computed gain lagging the optimum gain for a short period. Aircraft motion due to turbulence or aircraft vibration, such as experienced with speed brake operation, will cause the adaptive gains to decrease. When the pitch damper switch is turned OFF, the pitch gain is driven to its minimum of 12 percent, and the pitch damper servo centers. If the gain becomes high enough due to a malfunction to cause the adaptive frequency to persist, the gain can be reset to its minimum value by momentarily cycling the pitch damper switch OFF and then back to the DAMPER position. This should stop the oscillation.

Note

When the damper switch is positioned to the DAMPER position, the gains may require up to 2 minutes to increase to the optimum value. During this time the aircraft response and damping may be noticeably reduced. Consequently if the damper switch is cycled during TFR operation, aircraft response may be degraded up to one minute after the switch is returned to the damper position.

Pitch Gain Lock.

When the flight control system is in the takeoff and land configuration, the pitch gain is locked.

Artificial Stall Warning System.

On aircraft modified by T.O. 1F-111-891, the artificial stall warning system consists of a rudder pedal shaker, a stall warning lamp, and an audible stall warning signal. The system is automatically armed by the landing gear squat switch when the aircraft becomes airborne. The pedal shaker, lamp, and audible signal all occur simultaneously when either of the following conditions exists:

1. When the wings are swept forward of 50 (±2) degrees and the true wing angle-of-attack exceeds 14 (+0.25, −0.75) degrees.
2. When the wings are swept aft of 50 (±2) degrees and the true wing angle-of-attack is greater than 14 degrees, the stall warning system will be activated when the probe angle-of-attack, in degrees, (independent of the CADC) plus the pitch rate, in degrees per second, total 18 (±1). Since the angle-of-attack presented on the AMI is compensated as a function of mach number, the AMI reading for stall warning activation will vary as mach number changes. The AMI reading at which stall warning will occur for zero pitch rate is as follows:

Less than mach 0.30	18 (±1.6) degrees
Greater than mach 0.45 but less than mach 1.25	19.7 (±1.6) degrees
Greater than mach 1.40	18.8 (±1.6) degrees

In addition to the above conditions, when the flight control disconnect switch is in the OVRD position and the true wing angle-of-attack is greater than 14 degrees the stall warning lamp and audible signal will occur regardless of the wing sweep position, however the pedal shaker will be inoperative. The stall warning lamp (22, figure 1-6) is a flashing red lamp located on the left main instrument panel. When lighted the word STALL appears on the face of the lamp. Lamp intensity is controlled by the malfunction and indicator lamp dimming switch when the flight instrument lighting control knob is on. The audible stall warning signal is a continuous tone applied to the headsets of both crew members. The stall warning audible signal may be silenced by depressing the landing gear horn silencer button. Silencing of either the landing gear warning horn or the stall warning signal will not prevent subsequent audible tone warning from the other circuit. Operation of the horn silencer will not deactivate the stall warning lamp or the rudder pedal shaker. The system may be ground checked through use of the malfunction and indicator lamp test button.

On aircraft not modified by T.O. 1F-111-891 the system is automatically armed by the landing gear squat switch when the aircraft becomes airborne. The system will warn the pilot by shaking the rudder pedals when the angle-of-attack (in degrees) plus pitch rate (in degrees per second) total the values listed below. For zero pitch rate the pedal shaker will come on at the following angle-of-attack values for the airspeeds listed as read on the AMI:

*SPEED**	*ANGLE-OF-ATTACK*
• Less than mach 0.30	18 ± 1.6 degrees
• Greater than mach 0.45 but less than mach 1.25	19.7 ± 1.6 degrees
• Greater than mach 1.44	18.8 ± 1.6 degrees

*Use linear interpolation for speed regions not shown.

Pitch Channel Automatic Switching.

Certain changes occur within the pitch channel in the flight control system during the takeoff and landing phase. Automatic switching is accomplished by the

slat position and the weight on gear signals. The following describes the configuration for four different conditions:

1. Taxi—Weight on gear, slats down, pitch damper switch—DAMPER.
   a. Series trim is locked at its existing position but may be set to 3.8 degrees trailing edge up by the takeoff trim button.
   b. Parallel trim can be driven from the stick trim button(s) if auxiliary pitch trim switch is in STICK. When the stick trim button is depressed NOSE UP, the parallel trim actuator will drive the horizontal stabilizers, the control stick, the stick transducer, and the pitch damper in the nose up direction. The opposite will occur for nose down trim.
   c. Pitch Gains are locked.
   d. The stall warning device is not armed.
   e. Normal accelerometer signals are locked out.
2. Lift off—Slats down, weight off gear, pitch damper switch — DAMPER, auxiliary trim switch — STICK. Takeoff trim set prior to takeoff.
   a. Series trim is locked at 3.8 degrees trailing edge up.
   b. Parallel trim can be driven from the control stick trim button(s) to trim the aircraft as required.
   c. The stall warning device is armed.
   d. Normal accelerometer signals are locked out.
3. Cruise—Slats retracted, gear up, pitch damper switch — DAMPER.
   a. Series trim actuator is in the null mode.
   b. Pitch gain is in its adaptive mode and automatically increases or decreases the gain of the pitch damper command signal as flight conditions change.
   c. Parallel trim should be used to trim the aircraft to 1 "g" flight. The stick will be at neutral when this is accomplished.
   d. The stall warning device is armed.
   e. Normal accelerometer signals are active.
4. Slat Extension Prior to Landing
   a. Series trim actuator locks at its existing position.
   b. Parallel trim can be used to reestablish trimmed flight.
   c. The stall warning device is armed.
   d. Normal accelerometer signals are locked out.

Pitch Channel and Pitch Damper Redundancy.

All stability augmentation signals enter the pitch computer where they are converted into three command signals. Computer inputs are supplied from three separate sources to three identical pitch computer boards. Each board separately computes a pitch gain and a pitch command signal. The three separately computed command signals are inputs to signal selectors 1, 2, and 3. Each signal selector rejects the highest signal and the lowest signal. The output of each selector is the remaining signal, or the middle value signal. Each board has a signal comparator circuit, which compares that board's input signal with the selector's output signal. Should these signals be significantly different, the pitch channel caution lamp will light. For an initial failure, which causes a pitch channel caution lamp to light, the operation of the pitch damper system will be unaffected. However, a subsequent failure of another branch could result in (a) no change in operation, (b) zero pitch damper commands, or (c) a hard over pitch damper. The operation depends on the nature of the first, and subsequent failure(s). If the first failure resulted in a zero command from the affected board, normal operation can be continued and the pitch channel caution lamp can be reset. If the lamp cannot be reset, this means that the first failure is a hard over failure, and a second failure in the same direction will cause a hard over damper. For this reason, it is recommended that flight conditions be changed to observe the damper off envelope and then turn the pitch damper OFF. When the pitch damper is turned OFF, the pitch damper caution lamp will light.

Signal Selection.

The output of each signal selector will be the same for a single malfunction. Downstream of the signal selectors are three servo amplifiers, each of which receives its signal selector's output and in-turn sends a command signal to its separate servo valve within the pitch damper servo. When the pitch damper switch is turned OFF, the amplifier currents to the damper servo go to zero and the damper is hydraulically centered.

Damper Hydraulic Logic.

The pitch damper has two active valves and one model valve. The average of the command signals from the two active valves hydraulically control the movement of the damper output rod. A third servo valve controls a model servo and does not control the damper rod output. The position of the damper output rod and the position of the model servo are compared to detect malfunctions. Should a malfunction exist, the damper output rod position will not agree with the model servo position and the pitch damper caution lamp will light. Hydraulic logic within the pitch damper servo will identify the discrepant servo valve command. If the failure is due to one of the two active valves controlling the damper output rod, a vote will occur and the discrepant valve is hydraulically shut off. Control of the output rod is then dependent upon the command from the remaining active servo valve. A transient will

be felt in the aircraft when this vote occurs. The discrepant valve can be placed into operation by depressing the damper reset button. Should the valve still have a discrepant output command, another vote will occur and the valve will again be shut off. Should the discrepant valve be the model valve, the pitch damper caution lamp will light, but the pitch damper rod will not be affected, and a transient will not be felt.

Hydraulic Servos.

The two active servo valves which control the damper output rod are supplied from separate hydraulic systems. In the event of a single hydraulic system failure, the valve controlled by the failed hydraulic system will be hydraulically shut off, and the pitch damper caution lamp will light. Normal damper operation will continue by using the remaining active servo valve and hydraulic system. In this case the damper reset button has no effect unless hydraulic pressure returns to normal.

Pitch Gain Changer Redundancy.

Within the pitch computer, three separate circuits compute the required gain. These three outputs are processed through their gain selectors in the same manner described above for the signal selectors. The output of the gain selectors is the middle value gain. The gain of each damper command signal is varied according to that computed by the middle value gain control circuit. Should a discrepancy exist between the three separate gain calculations, a pitch gain changer caution lamp will light, indicating failure of one of the three circuits. Operation will be unaffected until a second failure occurs. If the gain changer light can not be reset, a second failure could cause the total gain to go to minimum, maximum, or be unaffected. For this reason, a decrease in airspeed is recommended.

ROLL CHANNEL.

Mechanical Linkage.

Lateral movement of the control stick is transmitted to the pitch roll mixer assembly by a system of push-pull rods and bellcranks. The pitch roll mixer adds the roll commands to the pitch commands and sends summed commands to the left and right horizontal stabilizer control valves and actuators. Figure 1-22 shows a simplified mechanical schematic of the roll channel linkage and damper system. Stick centering and stick feel forces are provided by the roll feel assembly. In this assembly, two feel springs are provided. When compressed, the low gradient feel spring provides nonlinear stick forces until its limit is reached at one-half stick travel. One-half stick displacement commands a 2-degree roll displacement through the pitch/roll mixer to each of the horizontal stabilizers with a stick force detent being encountered at this point. Approximately eight additional pounds must be exerted on the control stick before additional travel can be achieved. The high gradient feel spring breakout creates this force detent and provides the stick force gradient until maximum stick deflection is achieved. Maximum stick deflection commands 8 degrees of roll displacement through the pitch/roll mixer to each of the horizontal stabilizers. With the roll damper off the available stick deflection is limited by stick stops located within the cockpit to ±8 degrees of mechanical command. Figure 1-22 shows the gearing, and approximate stick force provided by the roll feel assembly. Stick breakout force is approximately 1.2 pounds. A 15-pound force is required to reach the detent; 31 pounds will give maximum stick deflection. The roll damper servo also provides roll control inputs to the pitch roll mixer. The roll damper is a redundant electrohydraulic servo actuator with an authority of ±6 degrees. The roll damper servo is used to provide roll trim, stability augmentation, and command augmentation to the horizontal stabilizers. The roll damper servo is identical to the pitch and yaw damper servos.

Power Supply.

The electrical power to the roll damper system is provided through the three computer power switches located on the ground check panel. Electrical power to the spoiler system is provided through the computer power switches, numbers 1 and 2. When these switches are OFF, spoiler operation for roll control is not available. When the roll damper is off, the roll damper servo actuator is hydraulically driven to its neutral position. When hydraulic pressure is not available, the position of the roll damper servo is indeterminate. A stick position transducer, located in the roll feel assembly sends nonlinear command signals to the roll damper and to the spoiler actuators.

Spoiler Operation.

When the wings are forward of 45 degrees, roll control is aided by action of two spoilers on the top of each wing. Each spoiler surface is actuated by a hydraulic servo actuator. The outboard pair of spoiler actuators has extension pressure supplied by the utility hydraulic system and has lock down pressure supplied by the primary hydraulic system. The inboard pair of spoiler actuators receives extension pressure from the primary hydraulic system and lock down pressure from the utility hydraulic system. Lateral movement of the control stick causes the stick position transducers to generate electrical command signals which are sent through the feel and trim and the wing sweep sensor assembly to the spoiler actuators. There is no mechanical linkage between the stick and the spoiler. Both commanded spoilers extend to a maximum of 45 degrees at the stick force detent. The spoiler extension versus stick displacement is nonlinear.

Roll Channel Electrical Schematic

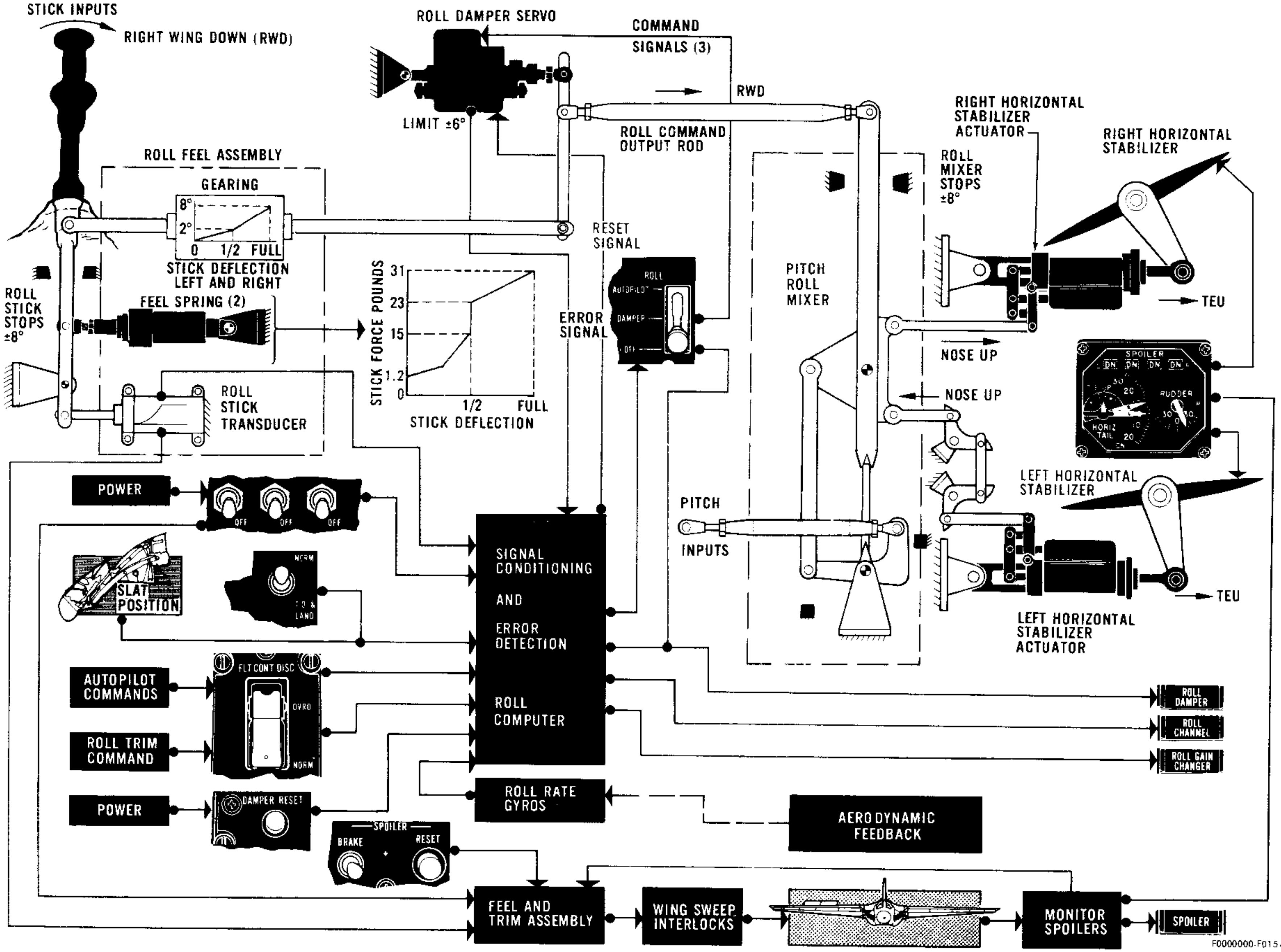


Figure 1-22.

Spoiler Lockout.

When the wing sweep angle is at 45 degrees, the electrical commands to the inboard spoiler actuators are switched out by the wing sweep sensor, causing the inboard spoilers to retract and lock down. At 47 degrees wing sweep, primary hydraulic pressure is removed from all spoiler actuators, and the electrical command signal to the outboard spoilers is switched out by the wing sweep sensor, causing them to retract and lock down. When the wing sweep reaches 49 degrees, the utility hydraulic pressure is removed from all spoiler actuators.

Spoiler Monitor.

When the wings are forward of 45 degrees, the spoiler monitor will lock the inboard pair or the outboard spoiler pair down should both left and right wing spoilers extend above 15 degrees due to a malfunction. If a spoiler inadvertently extends without being commanded and the aircraft starts a roll, the pilot would apply an opposite stick command to maintain wings level. Extension of spoilers on the opposite wing will cause the monitor, through a voting process, to cut off hydraulic pressure to the malfunctioning spoiler and its mate. This action will retract and lock the pair of spoilers in the down position and cause the spoiler caution lamp to light and result in reduced roll power. The spoiler monitor may be reset by depressing a spoiler reset button. This will cause the spoiler caution lamp to go out and will restore hydraulic pressure to the pair of spoilers that is locked down. If the malfunction still exists, the faulty spoiler will again extend and the previous sequence of events will be repeated. One attempt to reset a faulty spoiler is sufficient. In the event a spoiler extends because of a failure while roll autopilot is engaged, the wings must be held level by the pilot due to the limited roll authority of the autopilot. Roll autopilot does not move the control stick, and the pilot's control stick corrective motion will be required to operate the monitor. When the pilot moves the control stick to hold wings level, the monitor will vote and the failed spoiler will be locked down as previously described.

Stability Augmentation.

Roll stability augmentation is provided by redundant roll rate gyros and electronic computers used in conjunction with a redundant electrohydraulic roll damper servo to provide aircraft roll damping signals. (See figure 1-22.) The roll damper servo also responds to stick command signals from a nonlinear stick position transducer located in the control linkage. This same transducer supplies separate electrical commands to the inboard and outboard spoiler actuators.

Command Augmentation.

The effectiveness of any control surface varies with the flight conditions. At low speed and high altitude several degrees of differential horizontal stabilizer may be required to achieve a given roll rate; while at high speed and low altitude, it may take less than a degree. Also, the roll rate may be significantly increased when spoilers are operable. With the roll damper off, horizontal stabilizer displacement is proportional to stick displacement. With the roll damper on, the stability augmentation input causes roll damper commands to oppose aircraft roll rate. However, when the control stick is displaced, the roll damper also receives an input command signal from the stick position transducer through a lag circuit. This signal represents the commanded aircraft response and reduces the roll damper opposition to pilot initiated maneuvers and augments the pilot's stick input. The steady state roll damper displacement will be proportional to the difference between the commanded response and the actual aircraft response and is directly proportional to the roll adaptive gain. The horizontal stabilizer surface displacement due to control stick inputs will then vary with flight conditions so that variations in the resulting aircraft response will be minimized.

Roll Commands.

The control stick transducer output reaches the maximum at the stick force detent and represents a roll rate command of 160 degrees per second. The roll damper authority is ±6 degrees of differential horizontal stabilizer deflection, i.e., for a left roll the left surface displaces 6 degrees up and the right surface displaces 6 degrees down; the opposite occurs for a right roll. The actual damper deflection will depend on the commanded roll rate, the actual roll rate, and the roll adaptive gain. Refer to Roll Gain Control, this Section. If the stick deflection exceeds the detent, the total command (mechanical plus damper) may exceed the roll command limit. If this occurs, the excess roll command from the damper will cause stick talkback which may appear as pitch or roll stick movements.

Damper Off Operation.

When the roll damper is OFF, full stick deflection requires a force of 31 pounds. This will command the maximum of ±8 degrees of differential horizontal stabilizer deflection. When the roll damper is turned off, horizontal stabilizer control reverts to the direct mechanical linkage command to the horizontal stabilizer actuators.

Roll Trim.

Roll trim is accomplished through the roll damper servo. Roll trim command signals operate roll trim relays in the feel and trim assembly. These relays supply 26 volts ac to the roll trim integrator which is a motor driving an electrical transducer. This electrical transducer supplies a roll rate command signal to the roll computer which causes the roll damper servo to

position the horizontal stabilizer. Since the output of the roll damper servo is in series with the roll channel linkage, the control stick does not move as trim is applied. Roll trim is controlled by trim buttons located on each control stick. Approximately eight seconds is required to insert the maximum roll trim command. Roll trim is inoperative when the flight control disconnect switch is placed to OVRD or the roll damper switch is positioned to OFF. Under these conditions any previous roll trim inputs will be removed. The pilot can either hold stick force, or hold the wings level with yaw trim and accept the accompanying side slip when roll trim is not available.

Roll Gain Control.

The gain of the command signal sent to the roll damper servo is automatically varied as flight conditions change. This is accomplished by continuously monitoring the roll rate gyro signals to determine if the gain should be either increased or decreased. Since the system modifies its gain as a function of its own performance, it is called a self-adaptive gain system. In general the required gain varies inversely with dynamic pressure. A gain increase will compensate for reduced horizontal stabilizer effectiveness. If the gain is too low, the aircraft will appear sluggish to lateral stick commands. If the gain becomes too high, a small amplitude roll oscillation may exist for a few cycles until the gain control circuit, which senses this oscillatory condition, reduces the gain to the proper value. The frequency of this oscillation (the adaptive frequency) will be between 1.4 to 3.0 cycles per second. The gain changer is designed to either increase or decrease the gain for this range of frequencies depending on the amplitude and persistence. The gain will be increased for frequencies of less than 1.4 cps. Rapidly changing flight conditions can result in the computed gain lagging the optimum gain for a short period. Aircraft motion due to turbulence or aircraft vibration, such as experienced with speed brake operation, will cause the adaptive gains to decrease. When the roll damper switch is turned OFF, the roll gain is driven to its minimum value of 20 percent, and the roll damper servo centers. If the gain becomes high enough, due to a malfunction, to cause the adaptive frequency to persist, resulting in a small amplitude roll oscillation, the gain can be reset to its minimum value by momentarily cycling the roll damper switch OFF and then back to the DAMPER position. This should stop the oscillation. When the damper is turned on, the gains may require up to 2 minutes to increase to the optimum value. During this time the aircraft response and damping may be noticeably reduced. When in the takeoff and land configuration, the roll gain is locked at maximum.

Roll Channel and Roll Damper Redundancy.

The stick position transducer, roll rate gyros, electronic computers, gain control circuits, and the roll damper servo are redundant to the same extent as described under Pitch Channel Redundancy, this Section. An electronic malfunction causes either the roll channel or roll gain changer caution lamps to light. A damper malfunction will cause the roll damper caution lamp to light. The roll damper servo actuator is identical to the pitch and yaw damper servo actuator. Refer to "Spoiler Operation" this Section, for the redundancy features incorporated into the spoiler system.

YAW CHANNEL.

Manual control of the aircraft in the yaw axis is achieved by left or right pedal motion on either of two sets of rudder pedals. This movement is transmitted by cables, push-pull tubes, and bell cranks to the rudder control valve and rudder actuator. The control valve, located on the rudder actuator, controls the flow of hydraulic fluid from both the primary and utility hydraulic systems to the rudder actuator. Figure 1-23 is a simplified yaw channel mechanical and electrical schematic. Rudder pedal breakout (12 pounds) and centering is provided by the yaw feel spring. Rudder feel forces (80 pounds for available pedal travel) are provided by the yaw feel spring and the yaw variable feel actuator. The yaw variable feel actuator provides two rudder authorities: full pedal travel of approximately 2.5 inches and ±30 degrees of rudder deflection or limited authority of approximately 1-inch pedal travel and ±11.25 degrees of rudder deflection. The available authority depends on the slat position, the control system switch position, and the rudder authority switch position. A rudder authority caution lamp will light when available authority does not agree with the authority programmed by the slat position and the control system switch position.

Yaw Damping.

Aircraft damping is provided by the yaw damper servo. The yaw damper command and the yaw trim actuator command are summed with the rudder pedal command in the yaw feel assembly and then applied by mechanical linkage to the control valve of the rudder actuator. The authority of the yaw damper servo is ±15 degrees.

Rudder Limits.

Pedal stops are provided in the cockpit to limit rudder pedal travel. These stops allow ±30.75 degrees of rudder command. The total command to the rudder control valve is limited by the aft stop, which is set at 30 degrees (nominal).

Pedal Shaker.

A pedal shaker is attached to the pilot's left rudder pedal to provide stall warning. Refer to "Stall Warning," this Section.

Yaw Channel Schematic (Typical)

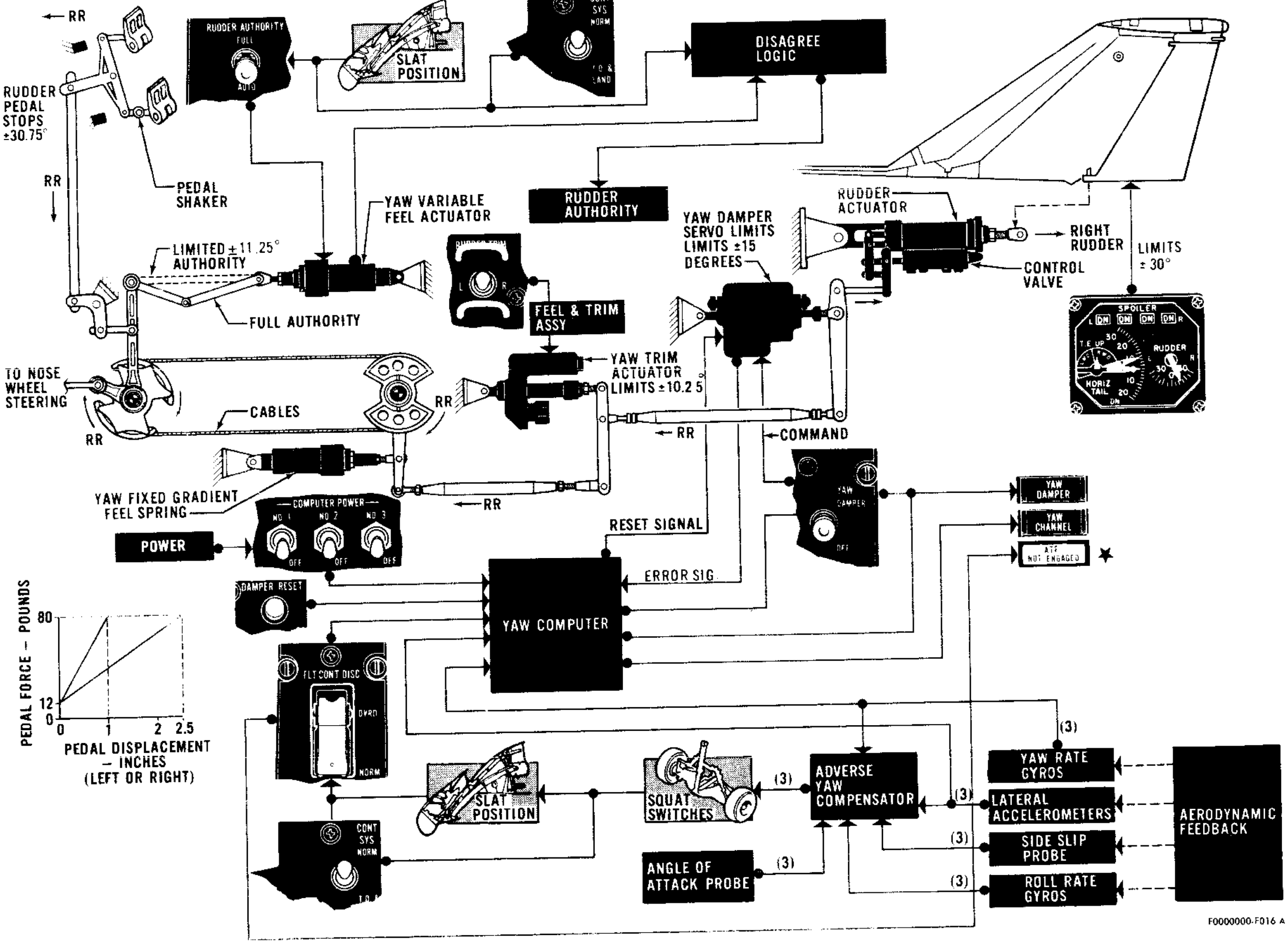


Figure 1-23.

Power Supply.

Power to the yaw damper servo is controlled from the computer power switches on the ground check panel.

Damper Off Operation.

The yaw damper is controlled from the yaw damper switch located on the autopilot/damper panel. When the yaw damper switch is turned to OFF, the yaw damper servo will hydraulically center, and the yaw damper caution lamp will light. When the yaw damper switch is returned to the DAMPER position, the yaw damper caution lamp will go out, and yaw damping will be immediately provided. If hydraulic pressure is not available, the position of the yaw damper servo is indeterminate.

Yaw Trim.

Yaw trim is accomplished by an electrically driven actuator which mechanically positions the rudder linkage. Since the yaw trim actuator is downstream of the yaw feel spring, there is no movement of the rudder pedals as trim is applied. Yaw trim is controlled by a rudder trim switch, located on the auxiliary flight control panel. Trim authority is ±10.25 degrees of rudder and the trim rate is 2.3 degrees per second. Hard over yaw trim that will not respond to the rudder trim switch will require about 80 pounds of rudder pedal force to hold the rudder centered in the normal flight configuration. In event of such a malfunction, the rudder authority switch may be used to increase rudder pedal authority and reduce the required force to approximately 30 pounds.

Yaw Stability Augmentation.

Yaw stability augmentation is provided through a fixed gain redundant yaw damper system to provide continuous aircraft damping. As in the case of the pitch and roll damper system, automatic failure detection and rejection is provided. Refer to Yaw Channel Redundancy this Section. Lateral acceleration and yaw rate signals are used as inputs to the yaw damping system. Yaw rate input is decreased as a function of time (washed out) to prevent the damper from opposing steady state pilot commands.

Adverse Yaw Compensation (AYC).

AYC is provided to improve turn coordination in the takeoff and landing configurations. This function is provided automatically whenever the slats are extended 70% or more. Turn coordination is improved by augmenting the directional stability with a sideslip to rudder feedback. This latter signal produces rudder in the direction of the roll and proportional to the roll rate. The roll rate feedback is gain adjusted as a function of angle-of-attack. AYC may also be obtained by placing the control system switch to the T.O. & LAND position. This should only be done below 300 KIAS or mach 0.45, whichever is less. The main gear squat switch deactivates AYC when weight is on the main gear. AYC can be switched out by placing the flight control disconnect switch in the OVRD position.

WARNING

Attempting abrupt rolling maneuvers or bank angles in excess of 60 degrees with the flight control system switch in T.O. & LAND, can result in loss of control of the aircraft.

Yaw Channel Automatic Switching.

The yaw damper system uses fixed gains; however, certain switching configurations occur as shown below for a typical takeoff and land cycle.

1. Pre-taxi—Control system switch—NORM, slats are retracted, weight on gear, yaw damper switch — DAMPER.
   a. Stability augmentation signal inputs are lateral accelerometer signals and washed out yaw rate gyro signals.

Note

If the aircraft is not on level ground, the rudder may be displaced slightly due to the lateral accelometer input into the yaw damper system.

   b. AYC is inactive.
   c. Rudder authority is limited, and full nose wheel steering is not available.
2. Taxi—Control system switch—NORM, slats extended, weight on gear, yaw damper switch — DAMPER.
   a. Stability augmentation inputs are fixed gain yaw rate gyro inputs, and lateral accelerometer inputs. Yaw damper displacement due to unlevel runways may be larger in this mode, compared to the retracted slat configuration because the yaw rate signal is not washed out.
   b. AYC is inactive.
   c. Rudder authority is full, and full nose wheel steering is available.
3. Lift off—Same as taxi, except weight is not on the gear.
   a. Stability augmentation inputs are lateral accelerometer signals and washed out yaw rate signals.

b. AYC inputs are accepted by the yaw damper system to improve turn coordination (AYC inputs are sideslip and adjusted roll rate inputs).
c. Rudder authority is full.

4. Slat Retraction—Gear up, yaw damper switch — DAMPER, Control System Switch—NORM.
   a. Stability augmentation inputs (yaw channel) are lateral acceleration and washed out yaw rate signals.
   b. AYC signals are switched out when slat extension is less than 70 percent.
   c. Rudder authority becomes limited when slat extension is less than 2 percent.

Yaw Channel and Yaw Damper Redundancy.

The yaw damping system utilizes redundant inputs for computing the required damping signals and uses signal selectors in the same manner as described under "Pitch Channel Redundancy," this Section. The yaw damper servo is a redundant unit and is identical to the pitch damper servo. Electronic failure causes the yaw channel caution lamp to light. A yaw damper malfunction will cause the yaw damper caution lamp to light.

FLIGHT CONTROL SYSTEM OPERATION CHARACTERISTICS.

Pitch Trimming During Maneuvers.

When parallel pitch trim is used to trim in a pitch command of one degree, the output of the pitch stick transducer will be only 30 percent of the value that would have been present had the stick been held in the same position. Thus the magnitude of the command signal to the pitch damper will be less when trim is used than when force is held for a given stick position. This means that for a constant altitude bank, the control stick must be trimmed to a further aft position than would be required if force is used to hold the same maneuver.

Roll Inputs.

During ground operation lateral stick inputs with the roll damper on will exhibit the following characteristics which are normal.

- The control stick cannot be held past the force detent. When the control stick is returned to neutral after a hard over deflection, the horizontal stabilizers will immediately change from 8 degrees of roll to 6 degrees, and after a small delay will return to zero roll. This delay is normal and is caused by the saturation of the roll damper system from the stick transducer.
- Rapid lateral stick motions with the roll damper on may result in a small bump being felt in the control stick and a momentary reduction in the affected spoiler position. This effect will be more pronounced at low engine rpm and is caused by rate limiting of the system.
- When roll trim is applied, the roll damper responds and moves the horizontal stabilizers. If the trim command switch is held several seconds, it will saturate the roll damper. When roll trim is then driven in the opposite direction, by either of the stick trim switches or by depressing takeoff trim, the stabilizers may take several seconds to begin to respond. This delay is normal, and represents the time required to bring the trim input below the roll damper saturation limits.

Stick Talk Back.

A condition known as stick talk back may be experienced whenever the pitch/roll mixer output to both or either horizontal stabilizer actuators is unable to respond to or lags the pitch/roll mixer input from damper servo or trim commands. Refer to Figure 1-19. When the pitch and roll dampers are on, the stick plus damper command may exceed the mixer limit as set by the mixer linkage stops. The damper response may also lag the stick command for large/rapid control stick inputs. Once the mixer authority is reached, additional damper or trim input will result in feedback to the control stick. This can be felt during ground operation by making large/rapid nose down control stick inputs. Control stick talk back can also be experienced whenever the rate of pitch or roll command into the mixer assembly exceeds the rate at which the horizontal stabilizer actuators can respond. The output rods from the pitch/roll mixer assembly control the left- and right-hand horizontal stabilizer actuators (refer to figure 1-19). Each actuator has its own control valve and feedback bellcrank. A nose up command displaces the control valve input rod aft; this ports fluid from both primary and utility hydraulic systems to each actuator and drives the horizontal stabilizers. When the feedback bellcrank has been repositioned by the actuator to a point where the control valve input is again at a null, the horizontal stabilizer actuator will stop. The stroke of each control valve is limited within the valve housing. This limit may be reached whenever the rate demand of the horizontal stabilizer actuator is greater than the maximum capability of the actuator. Should the limit of the valve stroke be reached, the mixer output rod will momentarily stop and will not respond to further pitch or roll inputs until the commanded rate can be satisfied by the actuator. During this period, a momentary control stick pulse will be felt. This may be noticed during ground operations ("Surface Motion Check") with programmed step inputs to the pitch and roll dampers or with rapid lateral stick inputs. The horizontal stabilizer actuators are are rate limited to 36 degrees per second.

PRE-TAXI CHECKS.

Control System Movement Check.

The control stick and rudder pedals are checked for freedom of movement while all dampers are off. During this check the pitch, roll, and yaw damper caution lamps should be on. The pitch, roll, and yaw channel lamps should not come on during this check. The mechanical linkage is checked for freedom and authority. If takeoff trim is first set, full stick deflection in pitch should cause a horizontal stabilizer indication of 10 degrees trailing edge down and 25 degrees trailing edge up. Roll stick displacement should cause a difference between left and right stabilizers of 4 degrees at detent and 16 degrees at full lateral stick displacement. Rudder control will be either full or limited, depending on the slat position and rudder authority switch position. Fore and aft motion of the control stick with the pitch damper on will result in stick talk back, which is normal. Lateral stick motion with the roll damper on may result in stick talk back, dependent upon the rate of application. The control stick cannot be held past the detent for this configuration. If lateral command inputs are made while maintaining large pitch inputs on the stick, stick talk back can be expected in the pitch direction.

Stability Augmentation Test Operation.

The purpose of the surface motion check is to ensure that all three damper systems will respond to three equal input signals by operating the appropriate damper servo without any malfunction. The purpose of the surface motion and lights check is to ensure that the error detecting system will detect the loss of one of the redundant branches in each channel and light the appropriate caution lamps. With all dampers on, all caution lamps out, flight control configuration normal, after takeoff trim is set, the stick is trimmed nose up momentarily to establish a nose up command to the pitch series trim actuator. Pitch series trim action is checked by verifying that both stabilizers drive trailing edge up until the trim authority limit is reached. After the stabilizers stop driving, the auto TF switch is placed to the AUTO TF position. This action causes the control stick to center, and the reference not engage caution lamp and TF fly-up off caution lamp to light. This switch action also effectively prevents the series trim actuator from driving while the surface motion test is in progress; however, stabilizer drifting may occur when this test is not in progress.

Surface Motion Check.

The master test button is depressed and the stability augmentation switch is held in the SURFACE MOTION position. This action causes all gyros in the pitch, roll, and yaw channels together with the accelerometers in the pitch and yaw channels to displace and send equal signals to the three computers. Unless a malfunction is present, all flight control system caution lamps will remain out; and the pitch, roll, and yaw dampers will displace as required in Normal Procedures, Section II. When the test switches are released, no caution lamps should light.

Surface Motion and Lights Check.

When the master test switch is held and the stability augmentation switch is placed to the SURFACE MOTION and LIGHTS position, two out of three gyros in the pitch, roll, and yaw channels are displaced but no accelerometers are torqued. This sends only two rate signals to each computer. The absence of the third branch is detected and all three channel caution lamps light. In addition, one branch of each servo is also failed and the three damper caution lamps will light. Further, in the pitch and roll axes, one branch of the gain changer is failed to minimum and this error is detected, causing the pitch gain changer and roll gain changer caution lamps to light. Thus eight lamps light and all three dampers displace as required in Normal Procedures, Section II. The damper reset button is used to reset all lamps after the flaps and slats are extended.

Stick Movement During Ground Checks.

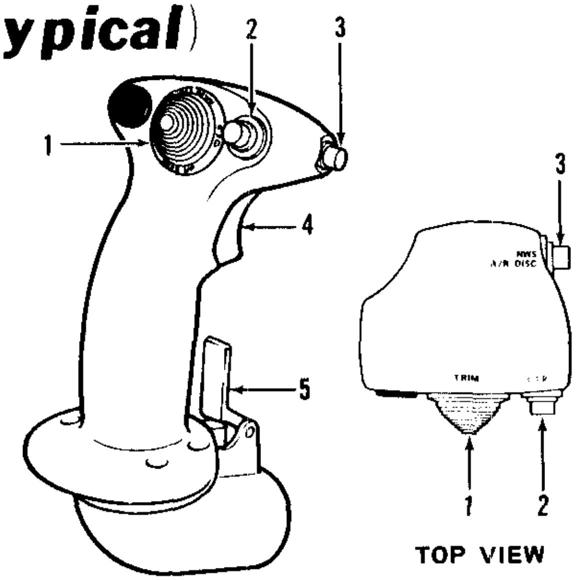
During the stability augmentation checks a rapid displacement of the control stick will occur. This is a normal condition. The stick should not be manually constrained during these checks since this will impose unnecessary loads on the stick-damper mechanical linkage.

FLIGHT CONTROL SYSTEM CONTROLS AND INDICATORS.

Control Sticks.

The two control sticks, one located at each crewmember's station, are mechanically interconnected. Prior to T.O. 1F-111(B)A-593, each stick grip (figure 1-24) contains a trim button, a reference engage button, a nose wheel steering/air refueling button, a gun trigger, and an autopilot release lever. After T.O. 1F-111(B)A-593, each stick grip (figure 1-24) contains a trim button, a constant track release button, a nose wheel steering/air refueling button, a gun trigger, and an autopilot release/pitch control stick steering lever. The control sticks also serve as a means of actuating the crew module bilge/flotation bag inflation pump. (Refer to "Crew Module Escape System," this section.) The right stick may be removed for various mission requirements. This must be accomplished while the aircraft is on the ground. When the right stick has been removed an electrical plug is inserted in place of the stick to maintain electrical continuity.

Control Sticks (Typical)



1. Trim Button.
2. Constant Track Release Button.
3. Nose Wheel Steering/Air Refuel Button.
4. Gun Trigger.
5. Autopilot Release/Pitch Control Stick Steering Lever.

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Figure 1-24.

Rudder Pedals.

Rudder control is provided by two sets of rudder pedals, one set located at each crewmember's station. The two sets of rudder pedals are mechanically interconnected, and in addition to controlling the rudder, each pedal operates the respective wheel brake in the conventional manner.

Stick Trim Button.

A trim button (1, figure 1-24), located on each control stick grip, is provided to control trim in the pitch and roll axes. The button has positions marked LWD, RWD, NOSE UP, NOSE DOWN, and is spring-loaded to the center unmarked OFF position. Moving the button to NOSE UP or NOSE DOWN causes the pitch trim actuator to position the horizontal stabilizer surfaces symmetrically with trailing edge either up or down as selected. Refer to "Pitch Channel," this section, for various trim authorities. Moving the button to LWD or RWD causes the roll damper servo to position the horizontal stabilizer surfaces asymmetrically as selected. The left stick trim button can always override the right stick trim button control. Approximately 8 seconds is required to trim the aircraft to its limit from neutral trim. When the roll damper is turned off, normal roll trim is inoperable and previous trim inputs are cancelled. The aircraft can be trimmed to the wings level position by use of rudder trim.

Auxiliary Pitch Trim Switch.

An auxiliary pitch trim switch (17, figure 1-25), with positions marked STICK, NOSE DN, NOSE UP, and OFF, is located on the left sidewall. When the switch is in the STICK position, pitch trim can be commanded by the trim buttons on the control sticks. When the auxiliary pitch trim switch is placed to the center (OFF) position, the auxiliary pitch trim system is armed. When the switch is placed to the NOSE UP or NOSE DN position, pitch trim is provided by one of the following:

1. Positioning an auxiliary pitch trim integrator, which sends command signals to the pitch damper.
2. Directly driving the pitch series trim actuator.
3. Both of the above.

With the switch in the OFF, NOSE DN, or NOSE UP position, pitch trim inputs from the control sticks are inoperative. Roll trim is not affected by the switch position.

Rudder Trim Switch.

A rudder trim switch (16, figure 1-25), located on the left sidewall, is provided for rudder trim control. The switch has positions marked L and R and is spring-loaded to the center unmarked OFF position. Holding the switch in L or R causes the rudder trim actuator to drive the rudder in the selected direction until the switch is released to OFF or a maximum deflection of 10.25 degrees is reached.

Takeoff Trim Button.

The takeoff trim button (26, figure 1-6), is located on the left main instrument panel. When the button is depressed, the takeoff trim relay is energized; the pitch parallel trim and yaw trim actuators are driven to 0 degrees; the roll trim integrator is synchronized so that the output to the roll damper is zero; the auxiliary pitch trim integrator is driven to a null; and the pitch trim series drives the horizontal stabilizers to 3.8 degrees trailing edge up. The button also functions during normal airborne operation.

Autopilot/Damper Switches.

Three switches, one each for the pitch, roll, and yaw channels, are located on the autopilot/damper panel. The pitch and roll damper switches (1, figure 1-26) are three position switches marked AUTOPILOT, DAMPER, and OFF. These switches are solenoid-held in the AUTOPILOT position, are spring-loaded to the

Left Sidewall (Typical)

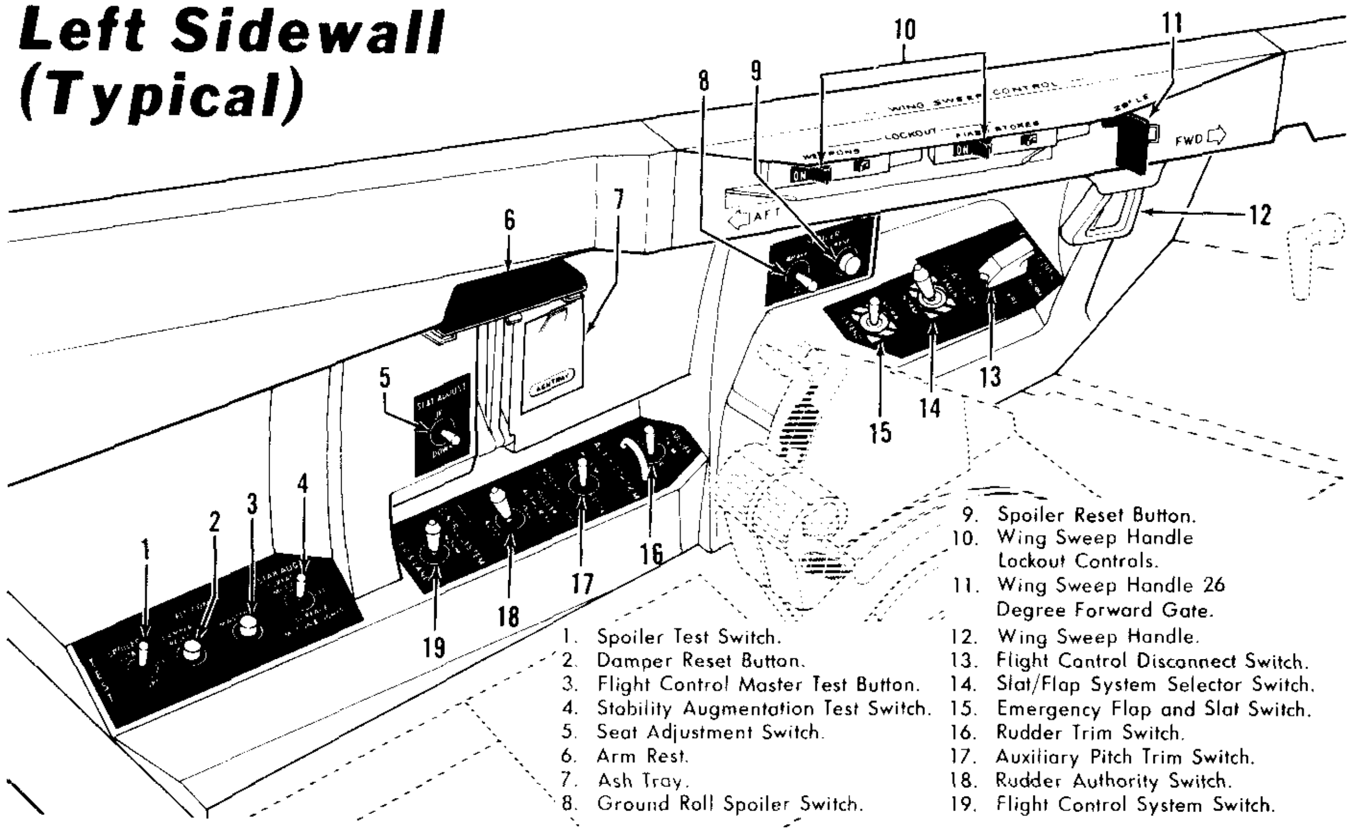


Figure 1-25.

DAMPER position, and are lever-locked in the OFF position. The switch lever of the pitch autopilot/damper switch is enlarged so that it can be readily identified by feel. The yaw damper switch (2, figure 1-26) is a two-position switch marked DAMPER and OFF. It is lever-locked in the OFF position and is spring-loaded to the DAMPER position. Placing any of the switches to DAMPER turns the respective damper on. The pitch and roll channels come on with the automatic gain at a low value and then begin setting the correct gain for that flight condition. Placing either the pitch or roll switch to AUTOPILOT will engage autopilot attitude stabilization. Placing a switch to OFF disengages the damper system of the respective channel and causes the respective damper caution lamp to light. These switches are also used to engage the autopilot. (Refer to "Autopilot System," this section.)

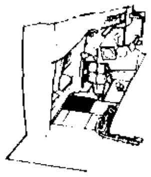
Auto Terrain Following Switch.

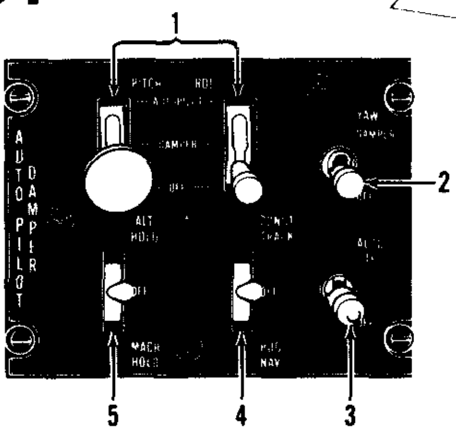
The auto terrain following (auto TF) switch (3, figure 1-26), located on the autopilot/damper panel, is a two-position lever-lock switch marked AUTO TF and OFF. The switch is locked in the OFF position and must be pulled out to move from OFF to AUTO TF. When the auto TF switch is in the OFF position, the aircraft must be flown manually to hold the terrain clearance selected by the TFR terrain clearance knob. In this switch configuration, the reference not engaged caution lamp (ATF not engaged lamp after T.O. 1F-111(B)A-593) will remain on. When the switch is placed to the AUTO TF position and either TFR channel mode selector knob is in the TF position, climb/dive signals from the TFR set will control the pitch damper and the series trim actuator. With the switch in AUTO TF the reference not engaged caution lamp (ATF not engaged lamp after T.O. 1F-111(B)A-593) will go out if the auto TF mode is engaged. When AUTO TF is selected, at least one TFR channel must be in the TF mode or the TF fly-up off caution lamp and the reference not engaged caution lamp (ATF not engaged lamp after T.O. 1F-111(B)A-593) will be lighted. For additional information on the auto TF switch, refer to "Terrain Following Radar," this section.

Damper Reset Button.

The damper reset button (2, figure 1-25), located on the left sidewall, is labeled DAMPER RESET. When the button is depressed, the pitch, roll, and yaw damper caution lamps and their respective channel caution

Autopilot/ Damper Panel (Typical)





1. Pitch and Roll Autopilot/Damper Switches.
2. Yaw Damper Switch.
3. Auto Terrain Following Switch.
4. Constant Track/Heading Nav Mode Selector Switch.
5. Altitude Hold/Mach Hold Selector Switch.

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Figure 1-26.

lamps on the main caution lamp panel will go out. Also the dampers and their respective electronic channels will be simultaneously reset to accept inputs for logic voting. If a malfunction is present at the time the reset button is released, the appropriate caution lamps will light. The button may also be used to reset the pitch and roll gain changer lamps.

Rudder Authority Switch.

The rudder authority switch (18, figure 1-25), located on the left sidewall, has positions marked FULL and AUTO. With the rudder authority switch in the AUTO position, full rudder authority of 30 degrees either side of center is available when the control system switch is in the T.O. & LAND position or NORM position and the slats are extended. With the switch in AUTO and the control system switch in NORM with the slats retracted, only limited rudder authority is available. When the rudder authority switch is in the FULL position, full rudder authority is available regardless of the slat position.

Flight Control System Switch.

The flight control system switch (19, figure 1-25), located on the left sidewall, is a two-position switch marked T.O. & LAND and NORM. The T.O. & LAND position is used in the event of a system malfunction. The NORM position is used at all other times, and the position of the slats determines the configuration of the flight control system. When the slats are extended the following takeoff and landing functions are automatically provided: The yaw variable feel actuator moves to the full authority position, the TFR signals are locked out, the pitch and roll computer gains are locked, and the pitch series trim actuator is locked at its present position. If weight is not on the gear, AYC is activated. When the slats are retracted, the following inflight (clean configuration) functions are provided: the pitch damper can respond to TFR signals (if present), the pitch and roll gains are automatically determined by the flight control computers as flight conditions change, the pitch series trim actuator is unlocked and operates in the null mode, and the yaw variable feel actuator moves to the limited authority position. A warning system is provided to indicate that the control system is not in the takeoff and landing configuration while airborne when the landing gear handle is in the DN position. In this event, both the pitch gain changer and roll gain changer lamps will light. Extension of the slats, or placing the control system switch to T.O. & LAND will place the control system in the takeoff and land configuration. The lamps will go out unless a malfunction is present or unless the flight control disconnect switch is in OVRD. Failure of the two lamps to go out is caused by the override action of the flight control disconnect switch on the adverse yaw compensation and pedal shaker systems. Use of the control system switch in this case will not cause the lamps to go out even though all other switching has taken place.

WARNING

> Attempting abrupt rolling maneuvers or bank angles in excess of 60 degrees with the flight control system in the takeoff and land configuration can result in loss of control of the aircraft.

Flight Control Disconnect Switch.

The flight control disconnect switch (13, figure 1-25), located on the left sidewall, has two positions marked NORM and OVRD (override). A red plastic guard covers the switch in the NORM position to prevent inadvertent actuation. Placing the switch to OVRD removes the following:

1. Pitch and roll autopilot commands.
2. Roll trim commands.
3. Pitch damper trim inputs (to the pitch damper).
4. TFR climb/dive commands to the pitch damper.
5. AYC and pedal shaker commands.

Also, the reference not engaged caution lamp (ATF not engaged caution lamp after T.O. 1F-111(B)A-593) will light when the switch is placed to OVRD. On aircraft modified by T.O. 1F-111-891, placing the flight control disconnect switch in the OVRD position will cause the stall warning lamp and audible stall warning signal to be activated any time the true wing angle of attack exceeds 14 degrees, regardless of wing sweep position. Functions not affected by the flight control disconnect switch are:

1. Stability augmentation.
2. Pitch series trim while the auxiliary pitch trim is in stick.
3. TFR fail safe fly-up maneuver.
4. TFR climb/dive commands to the pitch series trim actuator.

Flight Control Master Test Button.

The flight control master test button (3, figure 1-25), located on the left sidewall, provides power to the following:

1. Flight control test switches and buttons on the ground check panel.
2. CADC test switch on the ground check panel.
3. Stability augmentation test switch on the auxiliary flight control panel.
4. Spoiler test switch on the flight control switch panel.

Depressing the button applies power to the test switches and buttons. In addition, series trim is unlocked when the button is depressed. When the button is released, these switches and buttons are inoperable.

Accelerometer Test Button.

The accelerometer test button (12, figure 1-27) is located on the ground check panel. When depressed, in conjunction with the flight control master test button, all of the accelerometers in the pitch and yaw axes are torqued causing the rudder and horizontal stabilizers to displace. During this check, the rudder moves left and the horizontal stabilizers move trailing edge up due to the action of the yaw and pitch dampers. The yaw and pitch damper and channel caution lamps (4) should not light for this check.

Stability Augmentation Test Switch.

The stability augmentation test switch (4, figure 1-25), located on the left sidewall, is a three-position switch marked SURFACE MOTION and SURFACE MOTION & LIGHTS with an unmarked center OFF position. With the flight control system in the normal configuration this switch, when used in conjunction with the flight control master test button, provides a means of ground checking the stability augmentation system.

Spoiler Reset Button.

The spoiler reset button (9, figure 1-25), located on the left sidewall, is a momentary pushbutton labeled SPOILER RESET. The button is provided to reset the spoiler monitor in the event that a mafunction has caused a pair of spoilers to be voted out and locked down. If a pair of spoilers has been locked down and the spoiler caution lamp is lighted, depressing the spoiler reset button will cause the caution lamp to go out and the spoiler circuitry to be reset to accept signals from the spoiler transducers. If the malfunction still exists, the faulty spoiler will again extend and the corrective control stick motion will cause the spoilers to again lock down and the spoiler caution lamp to light.

Spoiler Test Switch.

The spoiler test switch (1, figure 1-25), located on the left sidewall, is a three-position switch marked OUTBD, OFF, and INBD. The switch is spring-loaded to OFF and is used in conjunction with the flight control master test button to ground check the operation of the spoilers. With the switch in OUTBD, depressing the master test button will cause the outboard pair of spoilers to extend momentarily and then lock down and the spoiler caution lamp will light. Depressing the spoiler reset button will return the spoilers to operation, and the spoiler caution lamp will go out. The INBD position of the switch is used to make the same check of the inboard spoilers. If the spoiler switch is moved from OUTBD to INBD (or vice versa) before the reset button is depressed, the first pair of spoilers locked down will be returned to operation; however, the caution lamp will remain on. This will invalidate the inboard spoiler check.

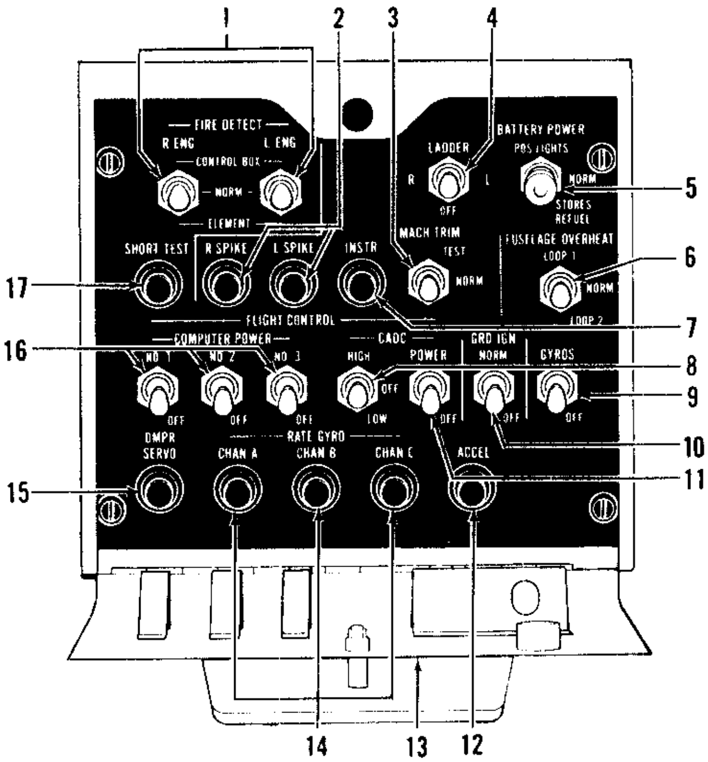
Computer Power Switches.

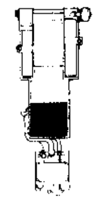
The computer power switches (16, figure 1-27) labeled NO. 1, NO. 2, and NO. 3 are located on the ground check panel. Each power switch controls the power to one branch of the pitch, roll, and yaw computers, and to other electrical flight control components. AC electrical power is supplied through the three computer power switches from the essential bus. When the switches are ON, and the electrical power is on the aircraft, 400-cycle electrical power is available to the entire flight control system. When these switches are OFF, the various trim functions, dampers, and spoilers can no longer be operated; and only the basic mechanical hydraulic system is available to operate the flight control surfaces. The switches must be in the ON position in order for the door on the ground check panel to be closed.

Damper Servo Button.

The damper servo button (15, figure 1-27), labeled DMPR SERVO, is located on the ground check panel.

Ground Check Panel





1. Engine Fire Detection System Ground Test Switches (2).
2. Spike Test Buttons.
3. Mach Trim Test Switch.
4. Entrance Ladder Switch.
5. Position Lights/Stores Refuel Battery Power Switch.
6. Fuselage Overheat Test Switch.
7. Instrument Test Button.
8. CADC Test Switch.
9. AFRS Power Switch.
10. Ground Ignition Cutoff Switch.
11. CADC Power Switch.
12. Accelerometer Test Button.
13. Ground Check Panel Access Door.
14. Rate Gyro Test Button (3).
15. Damper Servo Button.
16. Computer Power Switches (3).
17. Engine Fire Detection System Short Test Button.

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Figure 1-27.

When the damper servo, rate gyro channel B and channel C buttons, and flight control test master switch are depressed and held, the electrical power to valve No. 1 on each damper servo is interrupted. Electrical command signals from each computer, cause each damper servo to vote hydraulically. This causes the pitch, roll, and yaw damper and channel caution lamps (6) to light.

Rate Gyro Test Buttons.

The rate gyro test buttons (CHAN A, CHAN B, and CHAN C) (14, figure 1-27) are located on the ground check panel. When two or more of the buttons are depressed in conjunction with the flight control master test button, the respective rate gyros are torqued, resulting in a predetermined displacement of the primary flight control surfaces. Depressing the CHAN A button causes the "A" gyros to be torqued in the pitch, roll, and yaw channels. Depressing the CHAN B and CHAN C buttons causes their respective gyros to be torqued. When a single CHAN button and the master test button is depressed, all three CHANNEL lamps will light. The control surface motion, if any, will be less than 2 degrees.

Control Surface Position Indicator.

The control surface position indicator (18, figure 1-6), located on the left main instrument panel, is composed of three separate sets of indicators which provide indications of the positions of the spoilers, rudder, and horizontal tails (horizontal stabilizers). The position of the spoilers is indicated on four flip-flop type indicators, two for the left and two for the right spoilers. When the spoilers are retracted the letters DN appear in each indicator. As the spoilers extend, the indicators become blank. Rudder position is provided by a pointer on a scale, 30 degrees (L) left or (R) right of zero. The scale is graduated in 5 degree increments. The position of the horizontal stabilizer is indicated by two pointers, marked L and R. The indicator scale is 30 degrees up and 20 degrees down and is graduated in 2 degree increments. An index mark mounted on the axis of the left pointer provides indications of left or right wing down (LWD or RWD) against a scale mounted on the axis of the right pointer. In this manner asymmetric stabilizer position indications also provide left or right wing down indications.

Takeoff Trim Indicator Lamp.

A takeoff trim indicator lamp (25, figure 1-6), located on the left main instrument panel, is provided to indicate when the horizontal stabilizer and rudder are in the proper trim position for takeoff and the auxiliary pitch trim integrator is zeroed. When the takeoff trim button is depressed and all affected surfaces reach their proper position, the lamp lights. When the takeoff trim button is released, the lamp goes out.

Pitch, Roll, and Yaw Channel Caution Lamps.

Three amber caution lamps, one each for the pitch, roll, and yaw channels, are located on the main caution lamp panel (figure 1-29). Lighting of any one of the lamps indicates that a malfunction has been sensed in the computer of the respective pitch, roll, or yaw channel. Since the electronics in each channel is triple-redundant, lighting of one of these caution lamps indicates that one of the three sets of electronics is in error (passive first failure) and does not indicate a complete failure; however, it does indicate that system redundancy has been lost. (Refer to "Pitch Channel and Pitch Damper Redundancy," this Section.) A power supply failure in the yaw computer will cause a non-resettable yaw channel caution lamp to light. Such a failure can cause loss of response to TF climb/dive signals, loss of the TF fly-up capability, loss of the reference not engaged caution lamp (ATF not engaged caution lamp after T.O. 1F-111(B)A-593), TF fly-up off caution lamps, and loss of pitch or roll autopilot capability. For these reasons TF operation is not recommended and autopilot operation should be monitored closely if a non-resettable yaw channel caution lamp is lighted.

Pitch, Roll, and Yaw Damper Caution Lamps.

Three amber caution lamps, one each for the pitch, roll, and yaw dampers, are located on the main caution lamp panel (figure 1-29). Lighting of any one of the lamps indicates that a malfunction has been sensed in its respective damper. Since each damper has two active valves and a model valve, lighting of one of the caution lamps does not indicate a complete damper failure; however, it does indicate that system redundancy has been lost. Refer to Pitch Channel and Pitch Damper this Section.

Flight Control Spoiler Caution Lamp.

The flight control spoiler caution lamp, located on the main caution lamp panel (figure 1-29), is provided to indicate when a malfunction in the spoiler circuitry has occurred, causing a symmetric pair of flight control spoilers to be locked down. The lamp is also used in conjunction with the spoiler test switch when ground checking spoiler operation. (Refer to Spoiler Test Switch, this section.)

Roll and Pitch Gain Changer Caution Lamps.

Two amber gain changer caution lamps, one each for the pitch and roll gain changer, are located on the main caution lamp panel (figure 1-29). Lighting of either of these lamps indicates that a portion of the triple-redundant gain setting circuit in the respective channel is in error. Depressing the damper reset button will reset the lamp for a temporary error. Since the gain changer circuitry in each channel is triple redundant, lighting of one of these caution lamps indicates that one of these three sets of electronics is in error but does not indicate a complete failure; however, it does indicate that system redundancy is lost. Lighting of both lamps simultaneously will normally indicate a disagreement between the position of the control system switch and slats and the configuration of the flight control system. This will occur when the landing gear handle is in the DN position and the flight control system is not in the takeoff and land configuration. (Refer to "Pitch Gain Changer Redundancy" and "Flight Control System Switch," this Section.)

Rudder Authority Caution Lamp.

An amber rudder authority caution lamp (figure 1-29) is located on the main caution lamp panel. Lighting of the lamp indicates the rudder authority actuator is not in the position commanded by slat position and/or the control system switch. The rudder authority should switch to full authority when the slats are extended and to limited authority when the slats are retracted with the control system switch in the NORM position.

AUTOPILOT SYSTEM.

The autopilot operates in conjunction with the primary flight control system to control the aircraft during autopilot flight. The control stick does not follow the movement of the surfaces. The autopilot receives signals from the central air data computer (CADC) and from the bomb nav system. Pitch and roll attitude signals are obtained from the bomb nav or the AFRS system and are used as a reference and/or for damping during all autopilot modes. The CADC supplies a delta altitude or delta mach signal when altitude or mach hold modes are engaged. The ground track error and the heading navigation error signals are supplied by the bomb nav system.

Note

After T.O. 1F-111(B)A-593, magnetic heading information from the AFRS is used as a heading reference during the roll stabilization mode.

The autopilot system and the signals which are supplied to the autopilot are essentially non-redundant. However, the CADC has a failure indication capability which will light the CADS lamp should a malfunction occur in the CADC. In like manner, the bomb nav system has a failure malfunction detection system which will light the primary attitude and primary heading caution lamps when certain failures occur.

CAUTION

- The roll autopilot authority may be insufficient to hold the wings level with large asymmetric wing loading.
- Caution should be exercised in using the autopilot when a non-resettable yaw channel caution lamp is lighted since power may be lost to the pitch and/or roll autopilot circuits.
- Caution should be exercised in operating the autopilot if malfunctions exist affecting the attitude information on the ADI or altitude or altitude rate information displayed on the AVVI or, after T.O. 1F-111(B)A-593, AFRS magnetic heading.

Normally the autopilot receives attitude information from the bomb nav system. However, in the event of a bomb nav system malfunction, or when the instrument select switch is placed to AUX, the attitude reference source is switched to the AFRS. Attitude signals from either system are used as references by the pitch and/or roll damper systems to hold the aircraft at the reference attitude existing at the time of autopilot engagement. When the autopilot is not being used, the pitch and roll attitude signals are continuously synchronized in the flight control computer so that at the time of engagement of pitch or roll attitude stabilization, the respective synchronized signal is zero. If for some reason this signal is not zero, at the time attitude stabilization is selected, the mode will not engage. Also, if the attitude limits are exceeded, the mode will not engage. The nominal attitude limits are ±30 degrees in pitch and ±60 degrees in roll. Should these limits be exceeded in one or both channels, attitude stabilization will not engage in that channel until its attitude angle is reduced. In addition, the roll channel cannot be engaged if the yaw damper is OFF. The flight control disconnect switch must be in NORM to achieve proper autopilot operation in either the pitch or roll autopilot modes.

AUTOPILOT MODES.

The pitch autopilot modes are attitude stabilization, mach hold, and altitude hold. The roll autopilot modes are attitude stabilization, constant track and heading navigation. After T.O. 1F-111(B)A-593, attitude stabilization includes magnetic heading hold. Incompatible autopilot mode selection is prevented by circuit interlocks. Pitch attitude stabilization is in effect when the pitch autopilot is engaged unless either the mach or altitude submode is selected. Attitude stabilization will hold the aircraft on the reference pitch attitude. When the roll autopilot is engaged, roll attitude is in effect. However, after T.O. 1F-111(B)A-593, magnetic heading is also held when engagement is near wings level.

Mach Hold Mode.

The mach hold mode maintains constant mach. In this mode, mach is controlled by aircraft pitch attitude through operation of the horizontal stabilizer surfaces. Upon engagement of this mode, a mach reference is set up in the CADC. Any deviation of mach from this reference results in an error signal from the CADC. If mach increases above the reference, the resulting mach error signal will command a nose up attitude through the pitch damper and pitch series trim, causing the aircraft to return to the referenced mach number. An opposite command is used for a decrease in mach.

Altitude Hold Mode.

The altitude hold mode automatically maintains constant pressure altitude. Upon engagement of this mode, an altitude reference is established in the CADC. Any deviation in aircraft altitude results in an altitude error from the CADC. If the aircraft altitude increases above the reference, the resulting altitude error signal will command a nose down attitude through the pitch damper and pitch series trim until the desired altitude is obtained. An opposite command is given for a decrease in altitude.

Constant Track Mode.

The constant track mode maintains the aircraft on a constant ground track. When this mode is engaged, the existing ground track is sensed in the bomb nav system and is set up as a mode reference. Any deviation from this reference by the aircraft results in an error signal being sent from the bomb nav system to the roll computer. The roll computer, in turn, sends a command to the roll damper, correcting the deviation.

Heading Navigation Mode.

When operating in the heading navigation mode, the autopilot receives signals from the bomb nav system

to steer in accordance with the steering mode set by the instrument system coupler (ISC) mode selector knob. These modes are CRS SEL NAV, BOMB/NAV, CRS LINE, and MAN CRS. This steering signal is utilized by the roll damper system to steer the aircraft. The heading navigation position should not be used if the ISC mode selector knob is in a position other than those above.

Control Stick Steering.

When any autopilot mode is engaged, including basic attitude stabilization, autopilot operation can be disengaged by use of control stick steering. Prior to T.O. 1F-111(B)A-593, control stick steering is activated in the pitch channel by applying a force greater than 1.7 pounds in a forward or aft direction to the control stick. After T.O. 1F-111(B)A-593, pitch control stick steering is activated by depressing the autopilot release/pitch control stick steering lever to the first detent. Control stick steering is activated in the roll channel by applying a force of 1.3 pounds laterally to the control stick. Termination of control stick steering is accomplished by the reverse action used to engage it. When control stick steering is activated, the pilot can manually maneuver the aircraft as desired. When control stick steering is terminated, the autopilot will re-engage provided the attitude limits are not exceeded. Prior to T.O. 1F-111(B)A-593, attitude stabilization only will be engaged when control stick steering is terminated; submodes must be re-engaged if previously selected. After T.O. 1F-111(B)A-593, the selected modes will be automatically re-engaged.

AUTOPILOT CONTROLS AND INDICATORS.

Computer Power Switches.

Three computer power switches (16, figure 1-27), located on the ground check panel, control electrical power for autopilot and certain flight control system operations. (Refer to "Flight Control System," this section.) The autopilot is normally ready to engage after the power switches are placed in the ON position and the stabilization platform of the bomb nav system is properly erected.

Autopilot/Damper Switches.

Two autopilot/damper switches (1, figure 1-26), one each for pitch and roll, are located on the autopilot/damper panel and have three positions marked AUTOPILOT, DAMPER, and OFF. These switches are solenoid-held by 28 volt dc power in the AUTOPILOT position, are spring-loaded to the DAMPER position, and are lever-locked in the OFF position. The switch lever of the pitch autopilot/damper switch is enlarged so that it can be readily identified by feel. The switches operate independently of each other. When the switches are in the AUTOPILOT position, attitude stabilization is engaged and the aircraft will maintain constant attitude. When the switches are moved to DAMPER or OFF, all other mode switches will move to OFF and the aircraft will then revert to pilot-controlled flight. The pitch autopilot/damper switch will return to DAMPER when the auto TF switch is positioned to AUTO TF. After T.O. 1F-111(B)A-593, when airborne, the autopilot/damper switches will return to the DAMPER position when the slats are extended or the flight control switch is placed to T.O. & LAND. For additional information on these switches, as related to control of the roll and pitch dampers, refer to "Flight Control System," this section.

Constant Track/Heading Nav Mode Selector Switch.

The constant track/heading nav mode selector switch (4, figure 1-26), located on the autopilot/damper panel, is a three-position switch marked CONST TRACK, OFF, and HDG NAV. The switch is solenoid held by 28 volt dc power to CONST TRACK or HDG NAV and is spring-loaded to OFF. The switch will not latch in the CONST TRACK or HDG NAV positions unless the roll autopilot/damper switch is in the AUTOPILOT position. If, while operating in CONST TRACK or HDG NAV position, 28 volt dc power to the holding solenoid is lost, the switch will return to the OFF position. No caution lamp will light for this malfunction. When the switch is positioned to OFF, the constant track/heading nav operation will be discontinued.

Altitude Hold/Mach Hold Selector Switch.

The altitude hold/mach hold selector switch (5, figure 1-26), located on the autopilot/damper panel, is a three-position switch marked ALT HOLD, OFF, and MACH HOLD. The switch is solenoid held by 28 volt dc power to ALT HOLD or MACH HOLD and is spring-loaded to OFF. The switch will not latch in either ALT HOLD or MACH HOLD position if the pitch autopilot/damper switch is not in AUTOPILOT position. Selection of AUTO TF position on the auto TF switches is incompatible with altitude hold or mach hold mode and will cause the switch to move to the OFF position. If, while operating in MACH HOLD or ALT HOLD positions, 28 volt dc power to the holding relay is lost, the switch will return to the OFF position. No caution lamp will light for this malfunction.

Reference Engage Buttons.

Prior to T.O. 1F-111(B)A-593, a reference engage button (2, figure 1-24), marked REF ENGAGE, is located on each control stick grip. When any autopilot mode other than attitude stabilization is selected, one of the

reference engage buttons must be momentarily depressed before the mode will engage. Either button may be used to engage the autopilot.

Constant Track Release Button.

After T.O. 1F-111(B)A-593, a constant track release (CTR) button (2, figure 1-24), marked CTR, is located on each control stick grip. When the constant track submode is selected, the ground track reference can be changed (less than 7(±2) degrees) by depressing the CTR button on either control stick and manually flying to establish the desired track.

Autopilot Release Lever.

Prior to T.O. 1F-111(B)A-593, the autopilot release lever (5, figure 1-24), located at the base of the stick grip, permits either crew member to disengage certain functions of the autopilot without removing his hand from the stick. Depressing the lever will return the autopilot/damper switches to DAMPER. This disengages all autopilot functions and places the aircraft under pilot control. When the aircraft is being flown on TFR, the TFR commands can be interrupted by depressing and holding the autopilot release lever. The commands will reappear when the lever is released unless a mode other than TF is selected.

Autopilot Release/Pitch Control Stick Steering Lever.

After T.O. 1F-111(B)A-593, the autopilot release/pitch control stick steering lever (5, figure 1-24), located at the base of the stick grip, permits either crew member to disengage all functions of the autopilot by depressing the lever full travel to the second detent without removing his hand from the stick. Second detent activation returns the autopilot/damper switches to DAMPER and the autopilot submode switches to off. The first detent position of the lever allows pitch control stick steering (PCSS) with the pitch attitude stabilization mode engaged and also with mach hold or altitude hold submodes engaged without disengagement of any autopilot switches. Reengagement of the selected pitch modes is accomplished immediately upon release of the lever out of the first detent. When the aircraft is being flown on TFR, the TFR commands can be interrupted by depressing the lever to and holding it in the first detent. The commands will reappear when the lever is released out of the first detent.

Reference Not Engaged Caution Lamp.

Prior to T.O. 1F-111(B)A-593, the reference not engaged caution lamp (8, figure 1-6), located on the left main instrument panel, will light under the following conditions:

1. The autopilot/damper switches are in the AUTOPILOT position and control stick steering is being used.
2. Any autopilot mode (altitude hold, mach hold, constant track, or heading nav) is selected, and the reference engage button has not been depressed.

Note

The use of control stick steering in the axis of the autopilot mode that has been engaged will result in the mode being disengaged. The lamp will light and remain on until the reference engage button is depressed again.

3. Either TFR channel mode selector knob is in the TF position and the auto TF switch is OFF.
4. The auto TF switch is in AUTO TF and neither TFR channel mode selector knob is in the TF position.
5. The flight control disconnect switch is placed to the OVRD (override) position.

The letters REF NOT ENGAGED are visible in the face of the lamp when lighted.

ATF Not Engaged Caution Lamp.

After T.O. 1F-111(B)A-593, the ATF not engaged caution lamp (8, figure 1-6), located on the left main instrument panel, will light under the following conditions:

1. Either TFR channel mode selector knob is in the TF position and the auto TF switch is OFF.
2. The auto TF switch is in AUTO TF and neither TFR channel mode selector knob is in the TF position.
3. The flight control disconnect switch is placed to the OVRD (override) position.

The letters ATF NOT ENGAGED are visible in the face of the lamp when lighted.

AUTOPILOT PRINCIPLES OF OPERATION. (PRIOR TO T.O. 1F-111(B)A-593)

The autopilot modes are selected by positioning the respective mode switch on the autopilot/damper panel. The mode switches are magnetically held to the selected mode position and may be turned off by manually repositioning the switches to OFF or by momentarily depressing the autopilot release lever on either control stick. If a mode other than basic attitude stabilization is selected, the reference engage button on either control stick must be momentarily depressed to engage the selected mode(s). The reference not engaged caution lamp will light whenever a selected autopilot mode is not controlling. When the roll autopilot is engaged and the roll attitude is

less than 3.5 (±2) degrees, the aircraft will roll to wings level; if the roll angle is greater than 3.5 (±2) degrees the aircraft will maintain the roll attitude existing at the time of engagement. During autopilot operation on the AFRS attitude source, the AFRS gravitational erection system may slowly roll the aircraft; therefore, either constant track or heading nav submode must be engaged to maintain the aircraft in a wings level attitude. Also, to insure a reduction in AFRS gyro roll erection, bank angles of at least 10 degrees should be used when turning. If the constant track mode is selected, the roll damper will control the aircraft according to the new reference. However, when the constant track mode is discontinued, the autopilot will revert back to attitude stabilization and will maintain the attitude that existed at the time of disengagement. For example, if the roll autopilot is engaged with the aircraft in a twenty-degree bank, this bank angle will be held. If the constant track mode is then engaged, the aircraft will respond by returning to the reference ground track. If the constant track mode is subsequently discontinued, the autopilot will revert back to attitude stabilization.

Roll Submodes.

If a submode of the roll autopilot is desired, it may be selected by positioning the roll autopilot/damper switch to AUTOPILOT and by positioning the constant track/heading nav mode selector switch to either position. If CONST TRACK is selected, the aircraft should be flown until the desired ground track is reached, and then engaged by depressing the reference engage button on either control stick. If HDG NAV is selected, depress the reference engage button on either control stick, and the aircraft will fly the computed course to destination. When stabilized, the autopilot will hold the aircraft course within ±1 degree of the steering error command received from the bomb nav system. When the instrument system coupler mode selector knob is in the CRS SEL NAV, BOMB/NAV, CRS LINE or MAN CRS position, proper steering signals are available for autopilot operation. Depressing the autopilot release lever on either control stick will return the constant track/heading nav selector switch to OFF and the roll autopilot/damper switch to DAMPER.

Heading Navigation Mode Characteristics.

When the heading navigation or constant track mode is engaged, bank angle oscillations and heading overshoots may occur. When engaging with a large heading error, the bank angles may exceed 45 degrees.

Pitch Stabilization.

Pitch autopilot (altitude hold) may be engaged by placing the pitch autopilot/damper switch to AUTOPILOT. The mode will not engage if pitch attitude exceeds ±30 degrees. A new pitch attitude reference may be established by using control stick steering. The mode may be disengaged in the same manner as roll autopilot.

Altitude Hold Characteristics.

If the altitude hold mode is engaged while at a stabilized altitude, the flight control system will hold the reference altitude within ±60 feet unless engine power is changed, the wings are swept, or the speed brake is used. The altitude hold mode can be engaged up to 2000 fpm rate of climb or dive. The autopilot will cause the aircraft to appear to stabilize at an altitude slightly above or below the reference altitude. The aircraft will then slowly return to within ±60 feet of the reference. Changes in engine power, wing sweep, or speed brake operation while this mode is engaged will initially cause an altitude standoff, followed by a slow return toward the altitude reference.

Mach Hold Characteristics.

If the mach hold mode is engaged while at a stabilized flight condition, the flight control system will hold the reference mach number within ±0.01 mach under stabilized flight conditions. Changes in engine power or aircraft configuration will initially cause a corresponding change in mach number, followed by a slow return toward the reference mach number.

WARNING

- Pitch autopilot operation must not be attempted while the slats are extended or if the flight control system switch is in T.O. & LAND. To do so will result in improper operation and may cause abrupt transients when the autopilot is disengaged.
- Do not use the autopilot in the mach or altitude hold mode during operation in the transonic flight region between 0.90 and 1.10 mach. Attempts to do so may result in rapid pitch inputs.

The control stick will be centered and the pitch functions of the stick trim button will be inoperative when pitch autopilot/damper switch is placed to AUTOPILOT.

AUTOPILOT PRINCIPLES OF OPERATION. (AFTER T.O. 1F-111(B)A-593)

Pitch Autopilot Operation.

The pitch autopilot utilizes the pitch damper and the pitch series trim system to control attitude, altitude

(±60 feet), or mach number (±0.01 mach). Input signals to the pitch autopilot are attitude from either the bomb nav set or from the AFRS and/or altitude and mach number reference from the CADC. When the pitch autopilot/damper switch is placed to AUTOPILOT, the aircraft will capture the pitch attitude existing at the time of engagement if the attitude is within ±30 degrees. When either the mach hold or altitude hold mode is selected, the existing mach or altitude reference will be captured. During all pitch autopilot modes roll attitude is sensed so that additional up elevator will be supplied to compensate for loss of lift during turns. Pitch control stick steering is available through use of the first detent on the autopilot release/pitch control stick steering lever. When this lever is depressed and held, the existing reference (attitude, altitude or mach number) is disengaged and the pilot can manually fly the aircraft. When the new attitude, altitude or mach number is reached, the pilot releases the autopilot release/damper lever and the autopilot will capture the reference selected. The pitch autopilot/damper switch will drop to DAMPER and the altitude hold/mach hold selector switch to the OFF position when the second detent of the autopilot release/pitch control stick steering lever is used, when the flight control system is in the T.O. & LAND mode, or when the AUTO TF mode is selected (pitch only).

WARNING

- Do not use the autopilot in the mach or altitude hold mode during operation in the transonic flight region between 0.90 and 1.10 mach. Attempts to do so may result in rapid pitch inputs.
- Application of stick force in pitch while the autopilot is engaged without using the control stick steering (first detent) position of the autopilot release/pitch control stick steering lever will cause improper system operation. The aircraft will appear unresponsive to pilot inputs. Autopilot disengagement while holding stick force will cause a disengage transient.

Roll Autopilot Operation.

The roll autopilot utilizes the roll damper to control the aircraft attitude, heading, track or route to destination. Input signals are attitude from the bomb nav set or AFRS, magnetic heading from the AFRS directional gyro, and constant track or steering information from the navigation system. When the roll autopilot/damper switch is placed to the AUTOPILOT position, the yaw damper switch is placed to DAMPER, roll attitude is greater than 7 (±2) degrees, and there is no lateral force on the control stick, the roll autopilot will hold the existing roll attitude. For the same conditions except for the roll attitude being less than 7 (±2) degrees, the aircraft will capture the magnetic heading existing at the time of engagement.

Roll Attitude/Constant Heading Operation. Bank angles less than 7(±2) degrees—The autopilot system will maintain wings level and fly the magnetic heading as directed by the AFRS. Roll control stick steering (lateral stick force) may be used to establish a new heading. Bank angles greater than 7(±2) degrees—The autopilot system will maintain the bank angle established if less than 60 degrees.

Constant Track Operation. The autopilot system will capture and maintain the ground track reference existing in the bomb nav system at the time the constant track/heading nav selector switch is placed to CONST TRACK.

Note

- To initiate small changes in the established ground track without banking to more than 7 (±2) degrees, the constant track release (CTR) button on the control stick grip may be depressed and held until the aircraft is manually maneuvered to the new ground track and then released.
- To initiate large changes in the ground track reference, any one of three methods may be used:
  1. Roll control stick steering may be used to bank more than 7 (±2) degrees and the aircraft manually maneuvered to the new ground track reference. A new ground track reference will be established when the stick is centered for bank angles greater than 7 (±2) degrees or when the bank angle decreases through 7 (±2) degrees, if the stick is not centered.
  2. Position the constant track heading nav mode selector switch to OFF. Establish a desired bank angle of less than 60 degrees. Position the constant track/heading nav mode selector switch to CONST TRACK when the desired ground track is reached.
  3. Depress the CTR button and hold. Manually maneuver the aircraft to the desired ground track, center the stick and release the CTR button.

Heading Navigation Operation. The heading navigation mode is selected when the constant track/heading nav mode selector switch is placed to HDG NAV and the roll autopilot/damper switch is in AUTOPILOT. The autopilot will then control the aircraft to fly the computed course to destination. When stabilized, the autopilot will hold the aircraft course within ± 1 degree of the steering error command received from the bomb nav system. When the instrument system coupler mode selector knob is in the CRS SEL NAV, BOMB/NAV, CRS LINE or MAN CRS position, proper steering signals are available for autopilot operation. The mode can be overriden by using roll control stick steering (RCSS) to manually maneuver the aircraft. Depressing the autopilot release/pitch control stick steering lever on either control stick grip to the second detent will return the constant track/heading nav mode selector switch to OFF and the roll autopilot/damper switch to the DAMPER position.

AUTOPILOT PROCEDURES.

Engaging the Autopilot.

1. ADI—Check for normal indications.
2. Attain a safe altitude and trim the aircraft to the desired attitude.

WARNING

- Autopilot operation should not be attempted with asymmetrical lateral fuel loading. In this condition the aircraft may roll off the referenced heading and altitude without disengaging the submodes.
- Do not use the autopilot in the mach or altitude hold mode during operation in the transonic flight region between 0.90 and 1.10 mach. To do so may result in rapid pitch inputs.

Note

Autopilot operation cannot be engaged at attitudes exceeding ± 30 degrees in pitch and ± 60 degrees in roll.

3. Pitch, roll, autopilot/damper, and yaw damper switches—DAMPER.
   Check that all dampers are operating properly.
4. Flight instrument reference select knob—As applicable.
   If attitude signals from the bomb nav system are reliable, place the switch to PRI. If the AFRS is utilized for attitude information place the switch to AUX.
5. Roll and pitch autopilot/damper switches—AUTOPILOT.
   The control stick will be centered and the pitch functions of the stick trim button will be inoperative when pitch autopilot/damper switch is placed to AUTOPILOT.
6. Reference not engaged caution lamp—Out. (Prior to T.O. 1F-111(B)A-593)
   Check that the reference not engaged caution lamp goes out with no force applied to the control stick.
7. Engage either constant track or heading nav submode, if required. (Prior to T.O. 1F-111(B)A-593)

Note

Prior to T.O. 1F-111(B)A-593, if the AFRS is being utilized for attitude signals, a heading sub-mode must be engaged to maintain the aircraft in a wings level attitude.

Selecting the Autopilot Control Modes.

CAUTION

Do not use altitude hold or mach hold submodes during transonic speed range. Due to erroneous static pressure measurement during flight in the mach number range of 0.90 to 1.10, CADC mach number and altitude information to the autopilot will vary abruptly resulting in possible aircraft structural damage.

After the autopilot is initially engaged in attitude stabilization, the pilot may select a single control mode or a combination of compatible modes by means of the mode switches on the autopilot/damper panel. A mode affecting the pitch channel (mach hold or altitude hold) may be selected simultaneously with a mode affecting the roll channel (constant track or heading nav). However, two modes in the same channel cannot be selected simultaneously.

Note

The flight director system (FDC) provides no steering commands to the autopilot, therefore autopilot steering commands are not available for ILS, TACAN, MAN HDG or TKR RV modes of ISC operation.

The following procedures are for selecting each control mode after attitude stabilization has been engaged.

Selecting Altitude Hold or Mach Hold Modes. Manually maneuver the aircraft to the desired mach, altitude, or heading.

1. Altitude hold/mach hold selector switch—Select desired mode.
2. Reference engage button—Depress. (Prior to T.O. 1F-111(B)A-593.)

   If it is desired to change the reference speed, altitude, or heading, it will be necessary to disengage the respective mode while the change is made. After T.O. 1F-111(B)A-593, if it is desired to change the reference speed or mach, it is not necessary to disengage the respective mode. The change can be accomplished by holding the autopilot release/pitch control stick steering lever depressed to the first detent until the new desired airspeed or mach conditions have been reached. Upon release of the lever, the mach conditions existing at that time will be maintained provided the aircraft was in acceptable engagement limits.

Selecting Constant Track Mode. Prior to T.O. 1F-111(B)A-593, select constant track as follows:

1. Constant track/heading nav mode selector switch —CONST TRACK.
2. Reference engage button—Depress.

Selecting Constant Track Mode. After T.O. 1F-111(B)A-593, select constant track as follows:

1. Constant track/heading nav mode selector switch —CONST TRACK.

Note

The ground track reference can be changed without disengaging the constant track/heading nav mode selector switch, by banking more than 7(2) degrees or by depressing the CTR button on either control stick and manually flying to establish the desired track.

Selecting Heading Navigation Mode. Before T.O. 1F-111(B)A-593, select heading navigation mode as follows:

1. Instrument system coupler mode selector switch —Select CRS SEL NAV, BOMB/NAV, CRS LINE, or MAN CRS position.
2. Reference engage button—Depress.

Selecting Heading Navigation Mode. After T.O. 1F-111(B)A-593, select heading navigation mode as follows:

1. Instrument system coupler mode selector switch—Select CRS SEL NAV, BOMB/NAV, CRS LINE, or MAN CRS position.

Note

If roll control stick steering is used to change heading in the heading navigation mode, the aircraft will steer to the previous commanded heading when the control stick is centered unless the autopilot or the heading navigation sub-mode is disengaged.

Disengaging the Autopilot.

To disengage all autopilot functions and place the aircraft under pilot control, either depress the autopilot release lever (autopilot release/pitch control stick steering lever to second detent after T.O. 1F-111(B)A-593) or place the pitch and roll autopilot/damper switches to DAMPER. In either case, all the sub-mode switches will move to OFF.

CENTRAL AIR DATA COMPUTER SYSTEM (CADC).

The aircraft is equipped with a central air data computer system which provides aerodynamic intelligence to various control systems. The system consists basically of an electromechanical computer which processes raw data from the angle of attack probe, pitot-static probe, and a temperature sensor probe. The computer utilizes the following raw data: indicated static pressure, pitot pressure, total temperature, and indicated angle of attack. When this data reaches the computer, it is transformed into electrical signal outputs through an arrangement of transducers, mechanical linkage, and servo repeaters. The central air data computer is equipped with a failure monitoring system which continually monitors the computing functions. Should a computing function fail, a CADS caution lamp on the main caution lamp panel will light. If a computing function should fail, which affects the pressure altitude or indicated airspeed displays on the integrated flight instrument system, a warning flag will appear on the associated instrument. In addition, mach, angle of attack, and pressure altitude data good signals are supplied from the CADC monitor system to be used as failure monitor interlocks for the terrain following radar, the flight director computer system, and the bomb nav system. The computer requires 115 volt ac and 28 volt dc power. Listed below are the various aircraft systems served by the air data computer system, followed in parentheses by the computer outputs which go to the system:

1. Altitude-vertical velocity indicator (pressure altitude and vertical velocity)
2. Airspeed mach indicator (mach number, indicated airspeed, and true wing angle of attack)
3. Maximum safe mach assembly (pressure altitude, mach number, and true air temperature)

4. Flight control system (incremental mach number and incremental LOG static pressure)
5. Engine fuel control unit (mach number)
6. Spike caution lamp (mach number)
7. Bomb nav system (pressure altitude, true airspeed, static pressure, true air temperature, true body angle-of-attack and CADC data good)
8. True airspeed indicator (true airspeed)
9. Optical display sight (indicated airspeed)
10. Terrain following radar (true body angle-of-attack, true airspeed, and angle-of-attack failure monitor)
11. Angle-of-attack indexer (true wing angle-of-attack)
12. Environmental control (indicated airspeed and true air temperature)
13. Flight director (incremental pressure altitude and pressure altitude failure monitor)
14. Landing gear warning (indicated airspeed and pressure altitude)
15. Marker beacon (pressure altitude)
16. IFF (pressure altitude).
17. On aircraft after T.O. 1F-111-891, stall warning system (true wing angle-of-attack).

CADC POWER SWITCH.

The CADC power switch (11, figure 1-27), with positions POWER and OFF, is located on the ground check panel. When the switch is in the OFF position, no aircraft power is supplied to the CADC or the maximum safe mach assembly. Also, the CADS caution lamp will light and the OFF warning flags in the airspeed indicator and altimeter will appear. When placed in the POWER position, 115 volt, 400-cycle, single-phase ac power is supplied to the CADC and the maximum safe mach assembly.

CADC TEST SWITCH.

The CADC test switch (8, figure 1-27), with positions HIGH, OFF, and LOW, is located on the ground check panel. The switch is spring-loaded to the OFF position. When the switch is positioned to either HIGH or LOW a set of pre-selected test input values, high or low respectively, of mach, altitude and angle-of-attack are fed into the CADC for use with the various systems being checked. Normally the switch is used by the flight crew during functional or acceptance flight grounds checks or by maintenance for troubleshooting. The HIGH position is also used to ground check the total temperature probe heater. If CADC high or low tests are performed while the INS is operating (ALIGN or above), the vertical velocity and altitude outputs from the INS will be erroneous for 10 to 15 minutes after completing the CADC test. Therefore, an altitude calibration must be performed 10 to 15 minutes after completing a CADC test and prior to accomplishing an AILA, bomb run, or TFR operation.

CADC CAUTION LAMP.

The CADC caution lamp (figure 1-29), located on the main caution lamp panel, will light to indicate malfunctions in the central air data computer. The lamp will also light when the CADC power switch is in the OFF position when power is on the aircraft. When lighted the letters CADS are visible.

MAXIMUM SAFE MACH ASSEMBLY.

The maximum safe mach assembly (MSMA) receives mach number, pressure altitude, and true freestream air temperature signals from the central air data computer (CADC) and wing sweep position from the wing sweep sensor. The MSMA commands the maximum safe mach (MSM) bar on the airspeed-mach indicator (AMI) and the reduce speed warning lamp. The MSMA computes the maximum continuous safe mach (design speed) of the aircraft for wing sweeps between 16 degrees and 49 degrees based upon pressure altitude, wing sweep, and temperature. The actual aircraft mach number is compared with the computed safe mach in the MSMA which provides a signal to light the reduce speed warning lamp when the airplane reaches this allowable design speed. For wing sweeps greater than 49 degrees, the airspeed limits presented in Section V must be observed since the MSMA is designed to compute a limitation less restrictive than those presented in Section V. The MSMA utilizes 115 volt ac power from the essential ac bus through the CADC power switch and 28 volt dc power from the essential dc bus. A power failure to the MSMA will cause the CADC caution lamp to light.

CAUTION

The MSMA computes maximum safe mach (design speed) for wing sweeps between 16 degrees and 49 degrees based upon functions of pressure altitude and wing sweep. For wing sweeps greater than 49 degrees the maximum airspeed limits presented in Section V must be observed. Any flight speed or temperature restrictions which are more restrictive than the clean airplane design values are not considered in the MSMA and consequently, are not displayed on the AMI. This is true for temporary or permanent limitations.

AUXILIARY FLIGHT REFERENCE SYSTEM (AFRS).

The auxiliary flight reference system (AFRS) provides standby or backup attitude and directional information. The system consists of a directional and vertical gyro platform, compass control panel, remote compass transmitter (flux valve), and a control amplifier. Changes in aircraft attitude are detected by the vertical gyro and electrically transmitted to the standby attitude indicator at all times and to the attitude director indicator (ADI) whenever the flight instrument reference select switch is in the AUX position or in event of malfunction of the bomb nav system. The directional gyro and compass transmitter provide heading information to the bearing-distance-heading indicator (BDHI) at all times and to the ADI and horizontal situation indicator (HSI) whenever the flight instrument reference select switch is in the AUX position, in event of malfunction of the bomb nav system or when the instrument system coupler mode selector knob is in the TACAN or TKR RV positions. The vertical gyro is unlimited in roll but is limited to ± 82 degrees in pitch. The directional gyro is attitude stabilized by the vertical gyro. The AFRS compass provides three modes of operation: SLAVED, DG (directional gyro), and COMP (compass). The SLAVED mode provides gyro stabilized magnetic heading from the remote compass transmitter. This mode is designed for use at latitudes up to 70 degrees. At higher latitudes the horizontal component of the earth's magnetic field becomes too weak to provide reliable heading information and the DG mode should be used. In the DG mode the remote compass transmitter is disconnected from the system and the directional gyro operates as a free gyro to provide directional reference. Free gyro drift of the directional gyro will not exceed ± 1 degree per hour. In the DG mode, apparent drift of the directional gyro due to earth's rotation is corrected. The COMP mode provides magnetic heading directly from the remote compass transmitter without gyro stabilization. This mode of operation should only be used when the AFRS gyros are suspected to be unreliable. AFRS attitude unreliable and gyro fast erection is indicated by the auxiliary attitude (AUX ATT) caution lamp, the OFF flag on the standby attitude indicator, and the OFF flag on the ADI if it is receiving attitude information from the AFRS. After T.O. 1F-111(B)A-637, the attitude caution lamp will light when the auxiliary attitude caution lamp lights.

WARNING

Momentary power interruptions, such as electrical bus transfer, may cause the AFRS gyro to revert to automatic fast erection. If this occurs, gyro fast erection will be indicated as described above for the duration of the two-minute fast erection cycle.

The AFRS operates on 115 volt ac power from the ac essential bus and 28 volt dc power from the dc essential bus.

FLIGHT INSTRUMENT REFERENCE SELECT SWITCH.

The flight instrument reference select switch (1, figure 1-60), located on the miscellaneous switch panel, has two positions marked PRI and AUX. Placing the switch to the PRI (primary) position supplies pitch, roll and heading information from the bomb nav system to the following subsystems, as applicable.

1. Autopilot
2. Attitude Director Indicator
3. Horizontal Situation Indicator
4. Flight Director Computer
5. Terrain Following Radar
6. Optical Display Sight
7. Attack Radar
8. Doppler Radar
9. Astro Tracker

Placing the switch to the AUX (auxiliary) position supplies pitch, roll and heading information from the AFRS (auxiliary flight reference system) to all the above subsystems.

Note

If there is a difference between primary and auxiliary headings, verify DCC magnetic variation. If the magnetic variation is incorrect, the primary heading displayed to the pilot is in error. If the magnetic variation is correct, the auxiliary heading is in error. When the auxiliary heading is in error and it is selected, the TACAN magnetic bearing on the HSI/BDHI is correct but the relative bearing is in error. With an auxiliary heading error when primary heading is selected, the TACAN magnetic bearing and the relative bearing are incorrect. The CDI, bank steering bar, and autopilot steering corrections are usually valid with primary magnetic heading error on the ADI and HSI.

AUXILIARY FLIGHT REFERENCE SYSTEM POWER SWITCH.

The auxiliary flight reference system power switch (9, figure 1-27), located on the ground check panel, has positions GYROS and OFF. Placing the switch to GYROS supplies power to the AFRS, the BDHI, and the standby attitude indicator. Placing the switch to OFF de-energizes these components.

AFRS GYRO FAST ERECT BUTTON.

The auxiliary flight reference system gyro fast erect button (6, figure 1-60), located on the miscellaneous

switch panel, provides a means for fast erection of the AFRS. The button is labeled ATT GYRO FAST ERECT. During initial turn-on of the system (initial erection), the gyro will automatically erect at the fast rate. If re-erection is required due to the gyro erecting to a false vertical or the pitch limits of the gyro being exceeded, fast erection may be accomplished by depressing and holding the fast erect button until the attitude indicators return to normal.

Note

> To prevent erecting the gyro to a false reference, do not depress the button except when the aircraft is in a level attitude.

During initial erection or when the fast erect button is depressed, the AUX ATT lamp on the main caution lamp panel will light, the OFF flag on the standby attitude indicator will come into view, and if the flight instrument reference select switch is in the AUX position, the OFF flag on the ADI will come into view. After T.O. 1F-111(B)A-637, the attitude caution lamp will also light. During initial erection or whenever the fast erect button is depressed, the displacement gyroscope erects at a rate of approximately 12 degrees per minute.

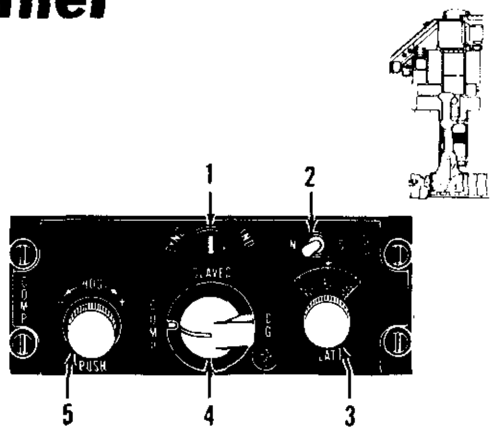
COMPASS MODE SELECTOR KNOB.

The compass mode selector knob (4, figure 1-28), located on the compass control panel, is used to select the mode of operation of the auxiliary flight reference system compass. The knob has three positions marked SLAVED, COMP, and DG. When the SLAVED mode is selected, gyro-stabilized magnetic heading from the remote compass transmitter is provided. In the DG mode, the remote compass transmitter information is removed from the system, and the system operates as a free gyro indicating an arbitrary gyro heading. In the COMP mode, the compass heading is obtained directly from the remote compass transmitter without stabilization by the directional gyro and is used in event of an attitude malfunction of the auxiliary flight reference system.

Note

> When moving the knob from the SLAVED position to COMP, the compass cards on the HSI and BDHI and the attitude sphere of the ADI will rotate off the heading and immediately return. This is normal. When moving the knob from COMP back to the SLAVED position, the compass cards of the HSI and BDHI and the attitude sphere of the ADI will rotate off the heading but will not return until the heading set knob is depressed and held to null the synchronization indicator.

Compass Control Panel



1. Synchronization Indicator.
2. Hemisphere Selector Switch.
3. Latitude Correction Knob.
4. Compass Mode Selector Knob.
5. Heading Set Knob.

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Figure 1-28.

LATITUDE CORRECTION KNOB.

The latitude correction knob (3, figure 1-28), located on the compass control panel, is marked with latitudes from 0 degrees to 90 degrees. Setting the knob to the latitude at which the flight is being made determines the rate of gyro drift correction when operating in DG mode and improves heading accuracy when operating in SLAVED mode.

HEADING SET KNOB.

The heading set knob (5, figure 1-28), located on the compass control panel, provides a means of rapidly synchronizing the AFRS directional gyro with the remote compass transmitter when operating in the SLAVED mode, and to set in desired heading on the BDHI when operating in the DG mode. When the compass is operated in the SLAVED mode, fast synchronization is accomplished by depressing and holding the knob depressed until the synchronization indicator on the compass control panel becomes centered. When the compass is operated in the DG mode, system heading is changed by depressing and turning the knob to the right to increase the heading and left to decrease the heading. The rate of heading change is determined by the amount the knob is turned. When the

compass is operated in the COMP mode, the system continuously tracks the remote compass transmitter and it is not necessary to use the knob.

HEMISPHERE SELECTOR SWITCH.

The hemisphere selector switch (2, figure 1-28), located on the compass control panel, has two positions marked N (North) and S (South). The switches must be positioned to the correct hemisphere in which the aircraft is operating to provide the proper balance of the earth's rate correction.

SYNCHRONIZATION INDICATOR.

The synchronization indicator (1, figure 1-28), located on the compass control panel, indicates whether or not the AFRS gyro and remote compass are synchronized. During operation in the SLAVED mode, the pointer will normally fluctuate slightly when the compass set is synchronized with the gyro. Should the compass get out of synchronization, the pointer will deflect toward either the plus or minus sign on the face of the indicator. The heading set knob must be depressed and held until the pointer is centered to synchronize the system. The indicator is de-activated when operating in the DG or COMP modes.

AUXILIARY ATTITUDE (AUX ATT) CAUTION LAMP.

The auxiliary attitude caution lamp (figure 1-29) located on the main caution lamp panel will light for the following conditions:

- Initial erection.
- Loss of electrical power to the AFRS.
- Detected attitude malfunction.
- Manual fast erection.

When lighted, the letters AUX ATT are visible. If the lamp lights for a malfunction (other than erection) the standby attitude indicator will be unreliable. Also the ADI will be unreliable if it has been switched to the AFRS attitude source.

AUXILIARY FLIGHT REFERENCE SYSTEM OPERATION.

Placing the auxiliary flight reference system power switch to GYROS applies power to the AFRS. The AFRS gyro will initially erect at the fast erection rate of 12 degrees per minute minimum for the first two minutes of operation. After the initial erection cycle, the gyro erection rate is reduced to 5 (±1) degrees per minute. If subsequent re-erection of the gyro is required, manual fast erection may be accomplished by depressing the ATT GYRO FAST ERECT button. The gyro pitch erection rate is reduced to one-fourth of the normal erection rate whenever the aircraft fore or aft acceleration exceeds 0.065 g. Since pitch erection is not completely removed, pitch errors may develop in the AFRS after prolonged aircraft longitudinal acceleration. Therefore, the vertical velocity indicator, altimeter, and angle-of-attack indicator should be cross-checked during aircraft acceleration to insure proper aircraft pitch attitude. The gyro roll erection rate is reduced to one-fourth of the normal erection rate whenever the aircraft bank angle exceeds 8.5 degrees.

Note

> When operating on AFRS as the primary source of attitude information, roll into turns at roll rates greater than one degree per second and maintain at least 10 degrees bank angle in turns to insure that the gyro roll erection rate is reduced. If the roll erection rate is not reduced during turns, the gyro will erect to a false vertical and erroneous aircraft roll attitude will be displayed.

Whenever the ADI is receiving attitude information from the bomb nav system, AFRS roll attitude errors resulting from erroneous gyro roll erection will result in disagreement between roll indications on the ADI and standby attitude indicator. If both the ADI and standby attitude indicator are receiving AFRS attitude information, the turn rate pointer on the ADI and the HSI compass card should be monitored in order that erroneous roll indications may be detected. If the compass is operating in the SLAVED mode, the remote compass transmitter magnetic heading signals are disconnected whenever gyro roll or pitch erection is reduced to prevent the system from synchronizing to erroneous headings caused by an unlevel heading sensor. Disengagement of the remote compass transmitter is indicated by an inactive synchronization indicator on the compass control panel. Initial synchronization of gyro heading when operating in the SLAVED compass mode, or positioning of the heading indicators to a known heading when operating in the DG compass mode, is rapidly accomplished by the heading set knob on the compass control panel. Subsequent resynchronization may be required if the pitch limits of the gyros are exceeded. In the SLAVED mode, the system will re-synchronize automatically at 1.5 (±0.5) degrees per minute if manual rapid synchronization is not accomplished.

WARNING, CAUTION, AND INDICATOR LAMPS.

In order to keep instrument surveillance to a minimum, warning, caution, and indicator lamps are located throughout the cockpit. All of these lamps except the master caution lamp are described under their respective systems. For location of the lamps throughout the cockpit, see figure 1-29.

Warning, Caution and Indicator Lamps (Typ)

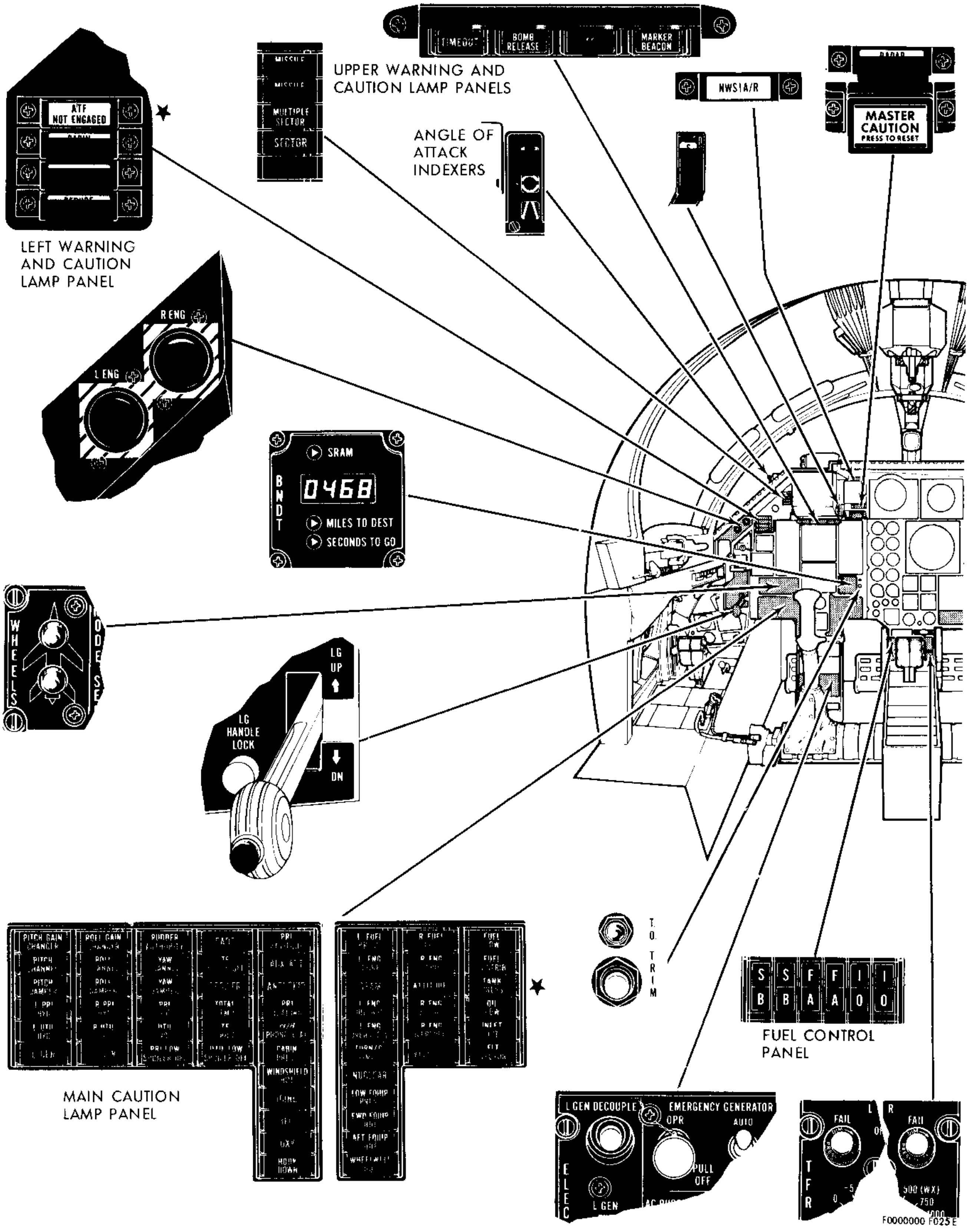


Figure 1-29. (Sheet 1)

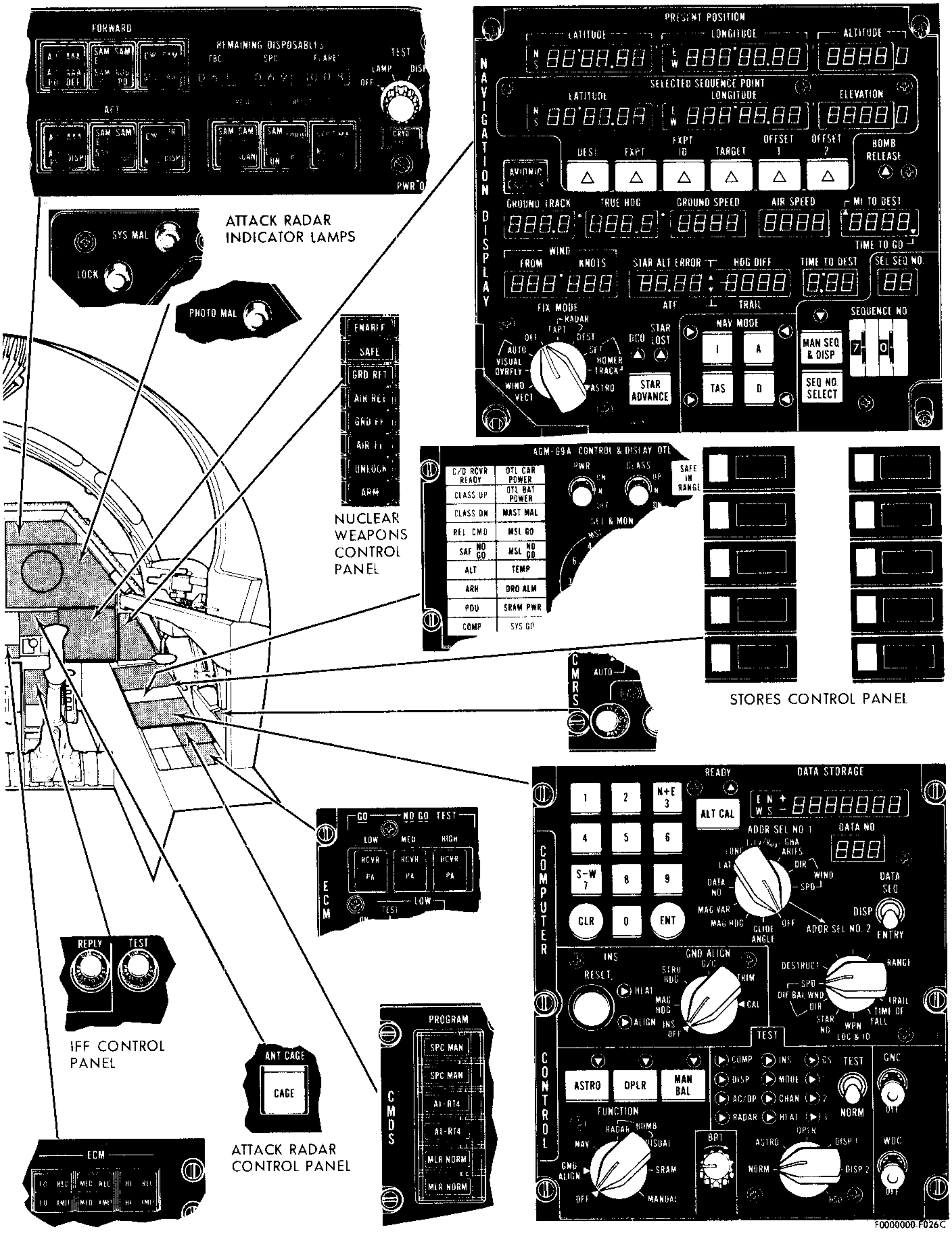


Figure 1-29. (Sheet 2)

MASTER CAUTION LAMP.

The master caution lamp (23, figure 1-6), located on the left main instrument panel, will light after a 3 second delay, to alert the crew that a malfunction exists when any of the individual caution lamps on the caution lamp panel lights to indicate a malfunction. The lamp will remain lighted as long as an individual caution lamp is on; however, it should be reset as soon as possible by depressing the face of the lamp so that other caution lamps can be monitored should additional malfunctions occur. The intensity of the lamp can be adjusted with the malfunction and indicator lamp dimming switch. The lamp can be checked by depressing the malfunction and indicator lamp test button.

Malfunction and Indicator Lamp Dimming Switch.

The malfunction and indicator lamp dimming switch (2, figure 1-68), located on the lighting control panel, is a three-position switch marked BRT (bright) and DIM and is spring-loaded to an unmarked center position. The switch controls the light intensity, either bright or dim, of all the warning, caution, and indicator lamps in the cockpit except the TFR channel failure caution lamps, the IFF reply and test lamps, and the NWS A/R indicator lamp.

Note

All lamps which are controlled by this switch are automatically set to bright under the following conditions:

- The internal lighting control knob (FLT INST) is off.
- Aircraft power is turned off.

Malfunction and Indicator Lamp Test Button.

The malfunction and indicator lamp test button (3, figure 1-68), located on the lighting control panel, is provided to check the landing gear warning horn and all warning, caution and indicator lamps in the cockpit except the following:

- TFR Channel Failure Caution Lamps
- IFF Reply and Test Lamps
- IRRS Ready/Test Indicator Lamp
- Engine Fire Pushbutton Warning Lamps
- All lamps on the attack radar scope, navigation, ECM and RHAW panels.

On aircraft modified by T.O. 1F-111-891, the malfunction and indicator lamp test button is used to ground check the stall warning system.

Note

On aircraft after T.O. 1F-111-891, during ground checks, with the flight control system switch in T.O. & LAND or with the slats down, depressing the malfunction and indicator lamp test button may cause the rudder to deflect due to an AYC input. In addition, when the test button is released, the YAW CHANNEL caution lamp may remain lighted. This lamp can be reset with the damper reset button.

PITOT STATIC SYSTEM.

The aircraft is equipped with a single pitot-static system which provides pitot and static pressures required for operation of standby instruments, the central air data computer (CADC) and the crew module "q"-actuated selector. The system consists of the pitot-static tube, mounted on an adapter installed on the forward tip of the radome, and the tubing required for connection to the operating components. The tubing includes two sets of drains and a static system manifold just forward of the instrument panel. Connections of both pitot and static pressures are made at the CADC unit and the standby airspeed indicator. The other standby instruments, the altimeter, and the vertical velocity indicator are connected only to the static system. The pitot-static probe is equipped with a heating element for anti-icing. (Refer to "Anti-icing and Defog Systems," this section.) For pitot-static system instrument error and difference between primary and standby instruments, see figure 1-30. It will be noted that a relatively large difference exists between the primary and secondary instrument readings on this figure. This is because the standby instruments are provided with uncorrected data from the pitot-static system, while the primary instruments are provided with data from the CADC which compensates for pitot-static system errors. Aircraft modified by T.O. 1F-111(B)A-554 are equipped with two independent pitot-static systems. The existing system, utilizing the nose probe, has been modified so that it provides pitot and static pressures to the central air data computer only. A secondary system, utilizing a probe mounted on the right side of the fuselage, has been installed to provide pitot and static pressures as applicable to the standby airspeed indicator, altimeter, vertical velocity indicator, and to the crew module "q"-actuated selector sensor. Both probes are equipped with heating elements for anti-icing and deicing.

INSTRUMENTS.

The instruments consist of the total temperature indicator (TTI), true airspeed (TAS), standby instruments and the integrated flight instrument system (IFIS).

Allowable Differences Between Primary and Standby Instruments

Date: 19 May 1972

AIRSPEED DIFFERENCE TOLERANCES

Airspeed— Knots	*Altitude — Feet*									
	Sea Level		*10,000*		*20,000*		*30,000*		*40,000*	
	*	**	*	**	*	**	*	**	*	**
100	+ 10 − 10	+ 6 − 12	+ 10 − 10	+ 7 − 11	+ 10 − 10	+ 7 − 11	+ 15 − 5	+ 8 − 10	+ 20 0	+ 8 − 10
200	+ 11 − 11	+ 10 − 13	+ 12 − 10	+ 11 − 12	+ 12 − 10	+ 11 − 11	+ 12 − 10	+ 11 − 11	+ 13 − 9	+ 11 − 11
300	+ 17 − 15	+ 16 − 16	+ 18 − 14	+ 16 − 16	+ 19 − 13	+ 16 − 16	+ 20 − 12	+ 15 − 17	+ 19 − 13	+ 11 − 21
400	+ 24 − 18	+ 21 − 21	+ 25 − 17	+ 21 − 22	+ 26 − 16	+ 19 − 23	Note 4		+ 23 − 19	+ 20 − 22
500	+ 31 − 21	+ 25 − 27	+ 33 − 19	+ 23 − 29	Note 4		+ 28 − 24	+ 25 − 27	+ 26 − 26	+ 24 − 29
600	+ 34 − 18	+ 21 − 31	Note 4		+ 28 − 24	+ 25 − 28	+ 26 − 26	+ 23 − 29	+ 26 − 26	+ 22 − 30

ALTITUDE DIFFERENCE TOLERANCES

Airspeed— Knots	*Altitude — Feet*									
	Sea Level		*10,000*		*20,000*		*30,000*		*40,000*	
	*	**	*	**	*	**	*	**	*	**
100	+ 100 − 100	+ 70 − 130	+ 180 − 180	+ 155 − 205	+ 275 − 275	+ 245 − 305	+ 400 − 390	+ 370 − 420	+ 600 − 580	+ 570 − 610
200	+ 105 − 95	+ 90 − 90	+ 200 − 160	+ 170 − 170	+ 310 − 240	+ 265 − 265	+ 460 − 330	+ 385 − 385	+ 730 − 450	+ 580 − 580
300	+ 140 − 60	+ 90 − 90	+ 255 − 105	+ 170 − 170	+ 420 − 130	+ 265 − 265	+ 685 − 105	+ 305 − 465	+ 985 − 195	− 50 − 1210
400	+ 220 + 20	+ 70 − 110	+ 405 + 45	+ 145 − 195	+ 690 + 140	+ 75 − 140	Note 4		+ 885 − 325	+ 500 − 660
500	+ 405 + 205	0 − 180	+ 700 + 340	− 90 − 430	Note 4		+ 655 − 135	+ 225 − 545	+ 590 − 590	+ 180 − 980
600	+ 690 + 490	− 285 − 465	Note 4		+ 565 + 15	+ 105 − 425	+ 395 − 395	− 90 − 860	+ 590 − 590	+ 540 − 620

NOTES:
1. Enter tables at primary instrument readings to obtain upper and lower limits on differences.
2. Subtract primary reading from standby reading to obtain difference (may be negative).
3. Do not interpolate across heavy lines.
4. Check not recommended at this condition.
5. Difference limits include indicator and CADC tolerances, and standby instrument position error.
6. Primary and standby altimeter set to 29.92 for the checks.

*Prior to T.O. 1F-111(B)A-554
**After T.O. 1F-111(B)A-554

Figure 1-30.

TOTAL TEMPERATURE INDICATOR.

The total temperature indicator (9, figure 1-6), located on the left main instrument panel, provides indications of aerodynamic heating. The indicator is an electrical-resistance type instrument that uses a remote temperature sensing probe, an amplifier, and a motor to position the indicator pointer. The temperature sensing probe is equipped with a heating element for anti-icing. (Refer to "Anti-Icing and Defog System", this section.) The face of the indicator is graduated in 10 degree increments from − 50 degrees to + 250 degrees centigrade, with a critical temperature index mark of 153 degrees and a maximum temperature index mark of at 214 degrees. A digital readout counter in the face of the indicator, marked SEC TO GO, indicates the time remaining for operation in the critical temperature range between 153 and 214 degrees. The indicator functions in conjunction with the total temperature caution lamp and the reduce speed warning lamp to provide the following indications: (1) When the critical temperature of 153 is reached the counter will start to drive down from 300 seconds toward zero and the total temperature caution lamp will light. (2) The counter will continue to drive until; (a) it reaches zero, (b) the temperature is reduced below 153 degrees or (c) the maximum temperature index of 214 degrees is reached. (3) When the maximum temperature index is reached or when the counter drives to zero the reduced speed warning lamp will light and the total temperature caution lamp will go out. (4) The counter will reverse and drive back to 300 seconds anytime the temperature falls below 153 degrees. (a) If the reduce speed warning lamp was on when the counter reversed it will go out. (b) If the total temperature caution lamp was out when the counter reversed it will light and remain on until the counter has driven back to 300 seconds. An OFF flag will appear in the face of the indicator when power is removed from the instrument or when the amplifier output signal varies from the temperature probe input signal by 10 to 12 degrees centigrade. The indicator operates on 115 volt ac power from the left main ac bus

Total Temperature Caution Lamp.

The total temperature caution lamp, located on the left main caution panel (figure 1-29), functions in conjunction with the total temperature indicator and reduce speed warning lamp to provide an indication that the aircraft is being operated in the critical temperature range between 153 degrees C and 214 degrees C. Refer to total temperature indicator this section for a description of lamp indications. When lighted, the words TOTAL TEMP are visible in the face of the lamp.

Reduce Speed Warning Lamp.

The reduce speed warning lamp, located on the left main instrument panel (figure 1-29), functions in conjunction with the total temperature indicator to indicate that the aircraft has flown for at least 300 seconds in the critical temperature range of from 153 to 214 degrees centigrade or that the maximum temperature index of 214 degrees has been reached or exceeded. Refer to Total Temperature Indicator this section for a description of the lamp functions in conjunction with the indicator. When lighted, the words REDUCE SPEED are visible in red on the face of the lamp. The lamp also functions in conjunction with the maximum safe mach assembly. Refer to "Maximum Safe Mach Assembly", this section.

TRUE AIRSPEED INDICATOR.

The true airspeed indicator (15, figure 1-31), located on the right main instrument panel, provides a digital readout of true airspeed. The instrument displays true airspeed on a servo-driven 4-digit counter within the range of 40-1750 knots. The indicator is operated by electrical signals from the CADC.

STANDBY INSTRUMENTS.

The standby instruments include the airspeed indicator, altimeter, vertical velocity indicator, magnetic compass, attitude indicator and bearing distance heading indicator (BDHI). These instruments provide backup indications in the event of failure of the integrated flight instrument system. Positon error must be applied to the airspeed and altimeter reading to obtain correct readings. Refer to "Appendix I, Part I".

Airspeed Indicator.

The airspeed indicator (3, figure 1-31), located on the right main instrument panel, is operated by pitot and static pressures direct from the pitot-static system. The instrument is graduated from 0.6 to 8 times 100 knots.

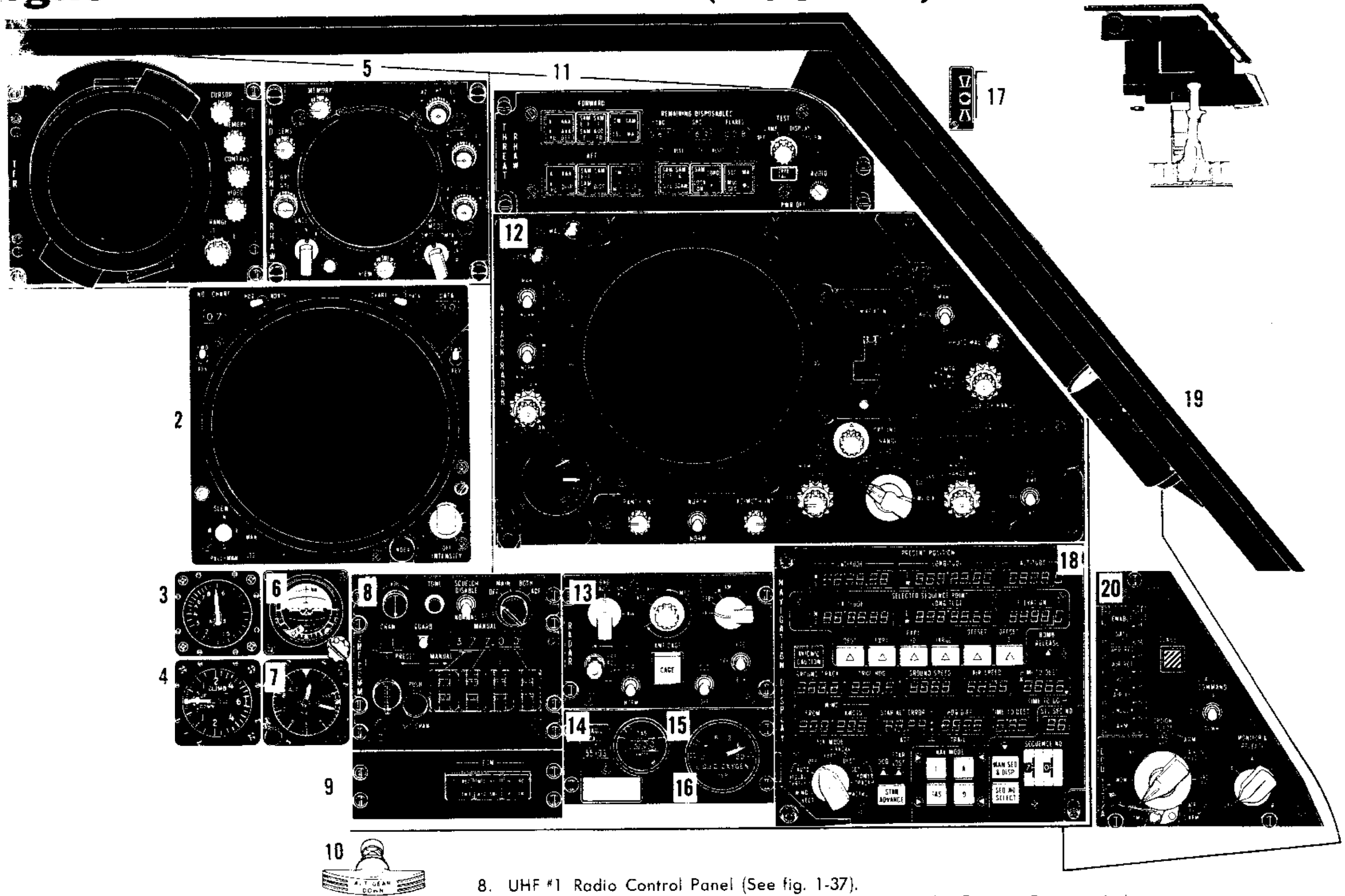
Altimeter.

The altimeter (7, figure 1-31), located on the right main instrument panel, is a barometric type which operates on static pressure direct from the pitot-static system. A barometric pressure set knob located on the left corner of the instrument provides a means of adjusting the barometric scale on the instrument.

WARNING

Do not push in on the set knob when setting barometric pressure as disengagement of the gear train between the indicating pointers and the barometric scale may occur, resulting in erroneous altimeter readings.

Right Main Instrument Panel (Typical)



1. TFR Radar Scope Panel (See fig. 1-62).
2. Horizontal Situation Display.
3. Standby Airspeed Indicator.
4. Vertical Velocity Indicator.
*5. RHAW Scope Panel.
6. Standby Attitude Indicator.
7. Standby Altimeter.
8. UHF #1 Radio Control Panel (See fig. 1-37).
*9. ECM Threat Panel.
10. Landing Gear Emergency (Alternate) Release Handle.
*11. RHAW Threat Panel.
12. Attack Radar Scope Panel (See fig. 1-56).
13. Attack Radar Control Panel (See fig. 1-54).
14. Radio Call Panel.
15. True Airspeed Indicator.
16. Oxygen Quantity Indicator.
17. Angle-of-Attack Indexer.
18. Navigation Display Panel (See fig. 1-48).
19. Utility Light.
**20. Nuclear Weapons Control Panel.

*See T.O. 1F-111(B)A-1B.
**See Weapons Delivery Manual.

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Figure 1-31.

Vertical Velocity Indicator.

The vertical velocity indicator (4, figure 1-31), located on the right main instrument panel, provides rate of climb and descent information. The instrument operates on static pressure from the pitot-static system.

Magnetic Compass.

The magnetic compass, located on the windshield center beam (13, figure 1-2), provides magnetic heading information. A deviation correction card for the compass is located below the center of the glare shield.

Attitude Indicator.

The attitude indicator (6, figure 1-31), located on the right main instrument panel, provides backup attitude information in the event of malfunction or failure of the attitude director indicator (ADI). The indicator displays pitch and roll information on an attitude sphere in relation to a miniature aircraft. Pitch and roll signals are received from the auxiliary flight reference system (AFRS). After T.O. 1F-111(B)A-637, an attitude monitor system is provided to compare pitch and roll signals to the ADI with those to the standby attitude indicator. Refer to "Attitude Monitor System," this section. The indicator receives 115 volt ac power from the ac essential bus. In the event of power failure or an AFRS malfunction, an OFF warning flag will appear on the lower left face of the indicator. A pitch trim knob on the lower right side of the instrument is provided to adjust the attitude sphere to the proper pitch attitude.

WARNING

The attitude warning flag will not appear with a slight electrical power reduction or failure of other components within the system. Failure of certain components can result in erroneous or complete loss of pitch and bank presentations without a visible flag.

Bearing-Distance-Heading Indicator.

Aircraft 3 ♦ 52 are equipped with a bearing-distance and heading indicator (BDHI) which is located on the right main instrument panel. The instrument is a remote-type heading indicator with a rotating compass card. TACAN bearing information is displayed by means of pointers. A synchro-driven range indicator is provided which receives signals from the TACAN set. Range of the distance display is 0-999 nautical miles. A red and black striped range warning flag partially obscures the range indicator when distance-to-station signals are too weak or there is a loss of lock-on to TACAN distance signals. Magnetic heading of the aircraft is shown by the index at the top of the instrument and the compass card. A pointer designated as No. 2 is servo-driven and receives signals from a TACAN coupler. Bearing information is read from the compass card under the pointer tip. The No. 2 pointer is positioned concurrent with the No. 1 pointer and rotates with it. The number 1 pointer is deactivated, therefore it will not be visible. The BDHI receives heading information from the auxiliary flight reference system (AFRS). The set index knob located on the lower right side of the indicator is used to set the heading index to a desired magnetic heading. Once set, the index rotates with the compass card. A flag marked OFF will appear in the window when the BDHI is not energized or when power is not available to the compass card.

INTEGRATED FLIGHT INSTRUMENT SYSTEM.

The integrated flight instrument system takes outputs from the following systems and integrates them into usable displays on the integrated flight instruments.

- Central air data computer (CADC)
- Auxiliary flight reference system (AFRS)
- Instrument landing system (ILS)
- Tactical air navigation system (TACAN)
- Terrain following radar (TFR)
- Radar homing and warning system (RHAWS)
- Bomb nav system
- Attack radar system
- Radar altimeter
- Optical display sight (ODS)
- Dual bombing timer (DBT)

The primary components of the system are the integrated flight instruments, consisting of the airspeed-mach indicator (AMI); altitude-vertical velocity indicator (AVVI); attitude director indicator (ADI); horizontal situation indicator (HSI);a flight director computer (FDC); and an instrument system coupler (ISC). The four integrated flight instruments are grouped together on the left main instrument panel to provide actual and command flight and navigational information in a clear concise manner. Altitude, airspeed, acceleration, mach, vertical velocity, and angle of attack are displayed on moving tapes on the AMI and AVVI. The ADI and HSI display attitude, heading, and navigational information from various other systems in the aircraft. The optical display sight (ODS) command steering bars operate in conjunction with the system to provide the same pitch and bank steering commands as the ADI. The instrument system coupler accepts inputs from other aircraft systems and channels them through the flight director computer for display on the ADI, ODS, and HSI. The system incorporates self-test

features to check reliability and isolate malfunctions. The AMI and AVVI receive power from the left main ac bus. The HSI receives 115-volt ac from the ac essential bus through the ISC. The other components of the system operate on 115 volt and 26 volt ac power from the essential ac bus and 28 volt dc power from the essential dc bus.

Airspeed Mach Indicator.

The airspeed mach indicator (AMI) (figure 1-32) provides remote reading vertical presentations of true wing angle of attack, "g" acceleration, mach airspeed and maximum safe mach on vertical moving scales. Readout windows below each moving scale present digital values for "g" acceleration, mach, and airspeed. Slewing switches for setting reference mach and airspeed markers are located on the bottom of the indicator. The slewing switches (54 and 52, figure 1-32), provide a manual means of setting command mach, and command airspeed markers. The value set is displayed in the command readout window above the respective slewing switch. The command airspeed slewing switch has a side detent position. This allows the command airspeed readout window to display a continuous digital airspeed in knots. When in the detent position the command feature is lost, as the command marker remains at the fixed index line. The command mach slewing switch does not have a detent position. Signals for operation of the various scales are provided from the central air data computer, maximum safe mach assembly, and remote accelerometer. In the event of power failure, OFF warning flags will appear across the mach number and airspeed scales. The (OFF) airspeed warning flag will appear in the event of a malfunction or failure in the airspeed section of the AMI or CADC. The circuit breaker for the airspeed mach indicator is located on the left main ac bus. Presentations on the face of the indicator are from left to right.

Note

> The airspeed indicated on the airspeed mach indicator has been calibrated for pitot-static system errors by the CADC and, therefore, is actually KCAS (knots calibrated airspeed). However, this airspeed is referred to as KIAS (knots indicated airspeed) throughout this manual, since it is read directly from the instruments.

Angle of Attack Indicating System.

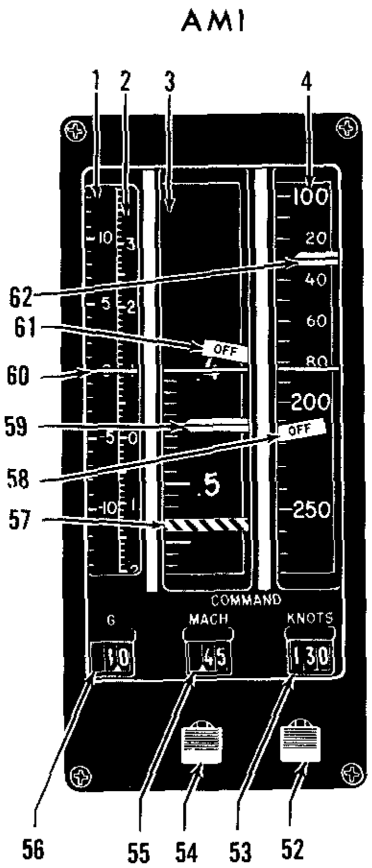
The angle-of-attack indicating system is composed of a conical probe transmitter located on the left side of the aircraft fuselage, an angle-of-attack correction cam in the central air data computer (CADC), two angle-of-attack indexers and a vertical scale read-out on the airspeed mach indicator. In flight, the angle-of-attack probe generates an indicated angle-of-attack signal which is sent to the CADC and corrected to true angle-of-attack. This correction is necessary since the indicated angle-of-attack contains position errors due to aircraft configuration as well as speed. The position error correction made in the CADC is accomplished as a function of mach number only, even though the actual position error is also a function of flap and slat configuration. Since flap and slat information is not supplied to the CADC, the correction cam is mechanized such that between mach 0.45 and 0.30 the position error correction is changed linearly from the flaps and slats retracted value to the flap and slat extended value. Between these two mach numbers the flaps and slats would be extended and the takeoff and landing configuration fully selected by 0.3 mach. If the aircraft is decelerated below mach 0.45 without extending the flaps and slats or accelerated past 0.3 with the flaps and slats extended, the position error correction applied by the CADC will be in error and the angle-of-attack indicator will no longer read the true aircraft angle-of-attack. For the flaps and slats retracted case, the angle of attack indictor will read lower than true angle of attack below mach 0.45. The error will increase linearly from 0 error of mach 0.45 (approximately 300 KIAS at S.L.) to 1.7 degrees at 0.30 (approximately 200 KIAS at S.L.). Below mach 0.3 the error remains constant at 1.7 degrees. For the flaps and slats extended case, the angle-of-attack indicator will read higher than true angle-of-attack above mach 0.30. The error will increase linearly from 0 error at mach 0.30 to 1.7 degrees at mach 0.45. Above mach 0.45, the error remains constant at 1.7 degrees. Since the angle-of-attack indexers are commanded by the same signal from the CADC as the indicator, the on-speed lamp will be lighted when the tape reads 10 degrees even though the true angle-of-attack may not be 10 degrees. Anti-icing is provided to the angle-of-attack probe. The heating elements receive power from the main ac bus and are controlled by the pitot/probe heat switch and the squat switch on the main gear.

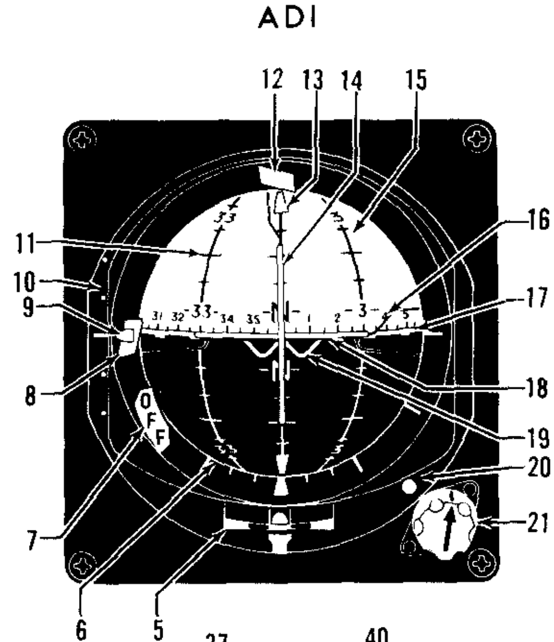
Note

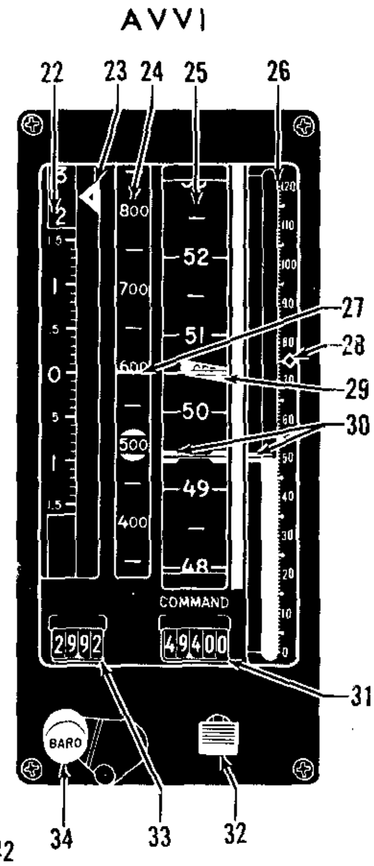
> Since the angle-of-attack indicator and indexers are commanded by the CADC, these instruments will be inoperative if the CADC is not operating.

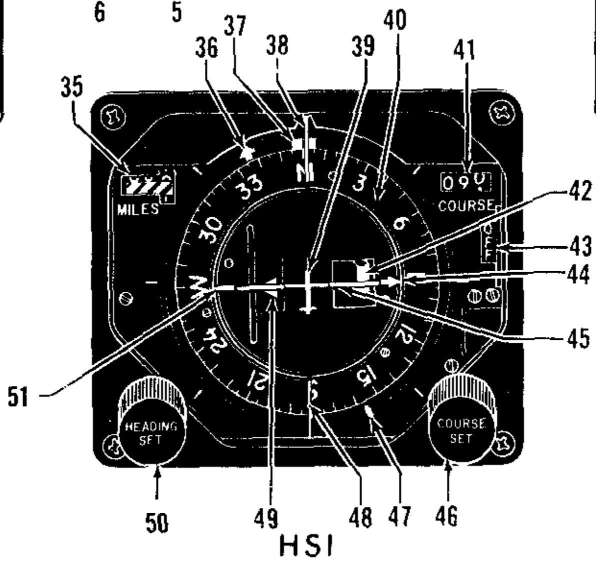
Angle of Attack Indicator. The angle of attack indicator, located on the airspeed-mach indicator, indicates in degrees the angular position of the wing chord in relation to the aircraft flight path and is primarily used for approach speed monitoring. The vertically moving tape displays angle of attack from minus 10 degrees to plus 25 degrees. The angle of attack indicator is operated by means of synchro signal received from the central air data computer.

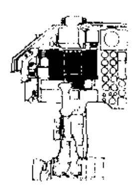
Integrated Flight Instruments











1. Angle of Attack Indicator.
2. Accelerometer.
3. Mach Indicator.
4. Airspeed Indicator.
5. Turn and Slip Indicator.
6. Bank Scale.
7. Attitude Warning Flag.
8. Glide Slope Warning Flag.
9. Glide Slope Indicator.
10. Glide Slope Deviation Scale.
11. Pitch Reference Scale.
12. Course Warning Flag.
13. Bank Pointer.
14. Bank Steering Bar.
15. Attitude Sphere.
16. Heading Reference Scale.
17. Horizon Bar.
18. Pitch Steering Bar.
19. Miniature Aircraft.
20. Pitch Trim Index.
21. Pitch Trim Knob.
22. Vertical Velocity Indicator.
23. Vertical Velocity Index.
24. Vernier Altimeter.
25. Coarse Altimeter.
26. Gross Altimeter.
27. Fixed Index Line.
28. Target Altitude Marker. (Inoperative)
29. Altitude Warning Flag.
30. Command Marker.
31. Command Altitude Readout Window.
32. Command Altitude Slewing Switch.
33. Barometric Pressure Readout Window.
34. Barometric Pressure Set Knob.
35. Tacan Range Indicator and Warning Flag.
36. Tacan Bearing Pointer.
37. Heading Marker.
38. Upper Lubber Line.
39. Aircraft Symbol.
40. Compass Card.
41. Course Selector Window.
42. Course Warning Flag.
43. Power Off Warning Flag.
44. Course Arrow Head.
45. Course Deviation Indicator.
46. Course Set Knob.
47. Bearing Pointer Tail.
48. Lower Lubber Line.
49. To-From Indicator
50. Heading Set Knob.
51. Course Arrow Tail.
52. Command Airspeed Slewing Switch.
53. Command Airspeed Readout Window.
54. Command Mach Slewing Switch
55. Command Mach Readout Window.
56. Acceleration Readout Window.
57. Maximum Allowable Mach Marker.
58. Airspeed Warning Flag.
59. Command Mach Marker.
60. Fixed Index Lines.
61. Power Off Warning Flag.
62. Command Airspeed Marker.

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Figure 1-32.

Angle of Attack Indexer. An angle of attack indexer (5, figure 1-6 and 17, figure 1-31) is located on either side of the glare shield. Each indexer consists of 3 lamps arranged vertically. The low speed symbol, the top V-shaped red lamp, lights when the angle of attack exceeds 10.5 degrees. The on speed symbol, the center donut-shaped green lamp, lights between 11.0 and 9.0 degrees. The high speed symbol, the bottom inverted V-shaped amber lamp, will light when the angle of attack is less than 9.5 degrees. The indexer lamps function only when the landing gear is in the down position. A dimming rheostat, located on the side of the indexer, controls the intensity of the lamps which receive 28 vdc power from the main dc bus. On aircraft modified by T.O. 1F-111-891 the angle-of-attack indexer lamps receive power from the 28 vdc essential bus.

Accelerometer. The accelerometer, located adjacent to the angle of attack indicator, provides normal "g" (load factor) information. The "g" forces being sustained by the aircraft are continuously shown by the acceleration scale read against a fixed index line. The tape scale is graduated from minus 4 to plus 10 "g". The presentation on the digital readout is from 0.0 to 9.0 "g". During negative acceleration a shutter will appear across the acceleration readout window. The accelerometer and readout window are actuated by electrical signals from the remote accelerometer.

Note

During abrupt pitching maneuvers, the "g" build-up may exceed the 2 "g" per second maximum speed of the accelerometer tape. If this occurs, the accelerometer indicator readings will be less than actual aircraft acceleration levels.

Mach Indicator. The mach scale in the center of the airspeed-mach indicator indicates true mach number, which is shown on a moving scale and is read against the fixed index. The scale is calibrated in hundredths and shows numbers in the tenths from 0.4 through 3.5. At speeds below mach 0.4, the scale will continue to read 0.4. The moving scale is operated by electrical signals from the CADC. A command mach marker and command mach readout window indicate manually selected command mach. The command mach marker remains at the top or bottom of the display column until the selected command mach comes into view on the mach scale, at which time it will synchronize and move with the scale. The selected true mach is numerically displayed in the command mach readout window at all times. Command mach setting is controlled manually by the command mach slewing switch under the command mach readout window. When selecting a command mach number, slewing speed is proportional to the amount the slewing switch is displaced from its normal center position. The maximum allowable mach is indicated by a diagonally striped maximum allowable mach marker which normally rests at the bottom of the mach scale. When maximum allowable speed is approached, the marker will climb toward the fixed index line. The maximum allowable mach marker will show on the scale depending on the aircraft wing sweep position, pressure altitude, and true temperature. The maximum allowable mach marker is operated by an electrical signal from the maximum safe mach assembly (MSMA).

Airspeed Indicator. The airspeed scale on the right column of the airspeed-mach indicator indicates airspeed on a moving scale read against a fixed index. The scale is calibrated in 10 knot increments and displays numerals at each 20 knot intervals from 100 to 200 knots and each 50 knot interval from 200 through 1000 knots. At speeds below 50 knots, the scale will continue to read 50. The airspeed scale is operated by electrical signals from the CADC. If there is a detected instrument failure or airspeed signal failure within the CADC, the IAS monitoring flag marked OFF will appear across the airspeed scale. A command airspeed marker and command airspeed readout window below the scale indicates selected command airspeed. Command airspeed setting is controlled by the command airspeed slewing switch under the command airspeed readout window. When selecting a command airspeed, slewing speed is proportional to the amount the slewing switch is displaced up or down from the center position. Once the command airspeed is set into the command airspeed readout window, the command airspeed marker remains at the top or bottom of the display column until the selected command airspeed comes into view on the moving scale, at which time it will synchronize and move with the reading on the scale. This will be the same reading as shown in the readout window.

Note

If the slewing switch is moved to the detented position on the right, the command airspeed marker will align with the fixed index and continuous digital presentation of the airspeed will then be displayed in the readout window.

Altitude-Vertical Velocity Indicator.

The altitude-vertical velocity indicator (AVVI) (figure 1-32) provides remote reading presentations of altitude and vertical velocity on vertical moving scales. Readout windows across the bottom of the indicator present digital readout of barometric pressure and command altitude. A barometric pressure set knob and command altitude slewing switch are also located on the bottom

of the indicator. Signals for operation of the moving scales, markers, and readouts are provided from the CADC. A spring-loaded OFF warning flag will appear across the face of the coarse altitude scale in the event of malfunction or power failure to the indicator. The barometric pressure reading is set by a knob marked BARO, located on the lower left corner of the indicator, and is numericaly displayed in the barometric pressure readout window above the knob.

WARNING

A mechanical failure within the altitude-vertical velocity indicator may not cause the flag to appear, even though the indicator reading will be unreliable. If a failure is suspected, rely on the standby altimeter using the position error shown in Appendix I, Part I. The radar altimeter also may be used since it provides an absolute indication of distance above the terrain at altitudes below 5000 feet.

Presentations on the face of the indicator are from left to right as follows:

Vertical Velocity Indicator. The vertical velocity indicator is located on the left side of the altitude-vertical velocity indicator. The instrument indicates climb or dive velocities from 0 to 1500 feet per minute by means of a moving index pointer to the right of a vertical fixed scale. The scale is graduated in increments of one hundred feet from 0 to 1.5 thousands. When the vertical velocity exceeds this scale, the pointer index will move to the top or bottom of the instrument to a readout window where a moving scale, graduated in thousands of feet from 2 to 40 thousand feet per minute, will indicate the rate of climb or descent. The instrument receives information from the CADC.

Vernier Altimeter. The altitude scales in the center of the altitude-vertical velocity indicator indicate aircraft pressure altitude which is read on the altitude scale against a fixed index line. The vernier scale is calibrated in 50 foot graduations and indicates each hundred foot level from 0 to 1000 feet. The coarse scale is calibrated in 500 foot graduations and indicates each thousand foot level from −1000 through +120,000 feet. Both the vernier and coarse scales are operated by electrical signals from the CADC. A command altitude marker and the command altitude readout window below the scale indicate manually selected command altitude. The command altitude numerals are controlled manually by the command altitude slewing switch under the command altitude readout window. When selecting a command altitude, slewing speed of the command marker and readout window numerals is proportional to the amount the slewing switch is displaced from center. The command altitude marker remains at the top or bottom of the display column until the selected command altitude comes into view on the altitude scale, at which time it will synchronize and move with the scale. The selected command altitude is numerically shown in the altitude readout window at all times.

Gross Altimeter. The gross altimeter, located on the right side of the altitude-vertical velocity indicator, is a thermometer-type altitude index which shows aircraft altitude against a gross altitude scale. It is operated by electrical signals from the CADC. The gross altitude scale is calibrated in thousands of feet and numerically indicates 10,000 foot levels from 0 to 120,000 feet. Command altitude is indicated by a double line command altitude marker and is simultaneously shown and operated in conjunction with the command altitude marker on the vernier altimeter.

Attitude Director Indicator.

The attitude director indicator (ADI) (figure 1-32), is a remote indicating instrument which displays attitude, heading, turn and slip, glide slope deviation, and bank and pitch steering information. The indicator includes an attitude sphere, turn and slip indicator, pitch and bank steering bars, miniature aircraft, glide slope indicator, warning flags, and a pitch trim knob. The attitude sphere displays pitch, bank, and heading in relation to the miniature aircraft. The pitch reference of the attitude sphere to the miniature aircraft may be adjusted with the pitch trim knob. The turn and slip indicator, located in the bottom of the ADI, receives turn signals directly from a remotely located rate-of-turn transmitter and is designed for a 4-minute turn. Pitch and bank steering commands from other systems are processed by the instrument system coupler and routed through the flight director computer to the pitch and bank steering bars and glide slope deviation indicator. (Refer to "Instrument System Coupler Mode Selector Knob" and "Instrument System Coupler Pitch Steering Mode Switch," this section, for ADI indications during various modes of operation. Attitude data to the ADI is received directly from either the bomb nav system inertial reference unit (IRU) or the auxiliary flight reference system (AFRS) depending on the position of the flight instrument reference select switch. Normal operation of the ADI is with this switch in the PRI position which provides the instrument with signals from the IRU. An off warning flag indicates loss of power to the ADI when data is being supplied from the bomb nav system. When data is being supplied from the AFRS, the warning flag indicates loss of power to the ADI or that the data is unreliable. It is possible to have failures within the ADI, AFRS or IRU that can result in erroneous or complete loss of attitude reference without the presence of a warning flag or caution lamp indication. Other

Instrument Warning Flag Analysis

INSTRUMENT	WARNING FLAG	FLAG CONDITION	DISPLAY VALIDITY	RECOMMENDED ACTION
Airspeed Mach Indicator	Power warning flag (Mach tape)	In View	All displays not reliable.	Use standby airspeed indicator.
	Airspeed warning flag (Airspeed tape)	In View (CADS) caution lamp out	Airspeed display not reliable.	Use standby airspeed indicator.
		In View (CADS) caution lamp on	Only acceleration display reliable.	Use standby airspeed indicator.
		Out of View (CADS) caution lamp on	Only airspeed and normal acceleration displays reliable.	Use airspeed and altitude for mach number determination.
Altitude Vertical Velocity Indicator	Altitude Warning Flag	In View	All displays not reliable.	Use standby altimeter and standby vertical velocity indicator.
Attitude Director Indicator	Attitude (OFF) Warning Flag	In View	Only turn and slip reliable.	Use standby attitude indicator.
	Course Warning	In View	Bank steering bar not reliable.	Use HSI course deviation indicator.
	Glide Slope Warning Flag	In View	Glide slope indicator not reliable. If TF submode engaged, pitch steering bar not reliable.	Use other landing mode or system.
Horizontal Situation Indicator	Power (OFF) Warning Flag	In View	All displays not reliable. Also, ADI bank steering bar not reliable if selected ISC mode requires manually setting HSI heading or course.	Use ADI heading and BDHI TACAN bearing and distance.
	Range Warning Flag	In View	Range indicator not reliable.	Use bearing-distance-heading indicator.
	Course Warning Flag	In View	Course deviation indicator not reliable.	Use ADI bank steering bar.
Bearing-Distance-Heading-Indicator	Power (OFF) Warning Flag	In View	All displays not reliable.	Use HSI.
	Range Warning Flag	In View	Range indicator not reliable.	Use HSI.
Standby Attitude Indicator	Power (OFF) Warning Flag	In View	Displays not reliable.	Use ADI.

Figure 1-33.

indications such as unrealistic or rapid changes in winds, ground speeds, or position, excessive radar cursor drift or unusual radar video uniformity, sudden attitude changes while on autopilot or frequent fly-ups while on TF may also indicate a possible erroneous attitude reference. When abnormal disagreement between the ADI and standby attitude indicator is encountered without a warning flag or caution lamp indication, the aircraft should be returned to level flight using basic flight instruments. Do not assume either indicator is reliable until the aircraft is straight and level and one of the indicators is determined to be accurate. If the above checks have determined a malfunctioning IRU, the ADI source should be switched to the AFRS. A continuing attitude discrepancy indicates an ADI malfunction, therefore, the standby attitude indicator should be used. After T.O. 1F-111(B)A-637, an attitude monitor system is provided to compare pitch and roll signals to the ADI with those to the standby attitude indicator. Refer to "Attitude Monitor System," this section.

WARNING

Frequent cross checks between the ADI, the standby attitude indicator and other basic flight instruments should be made to detect possible malfunctions. Failure to detect a malfunction and take corrective action could result in a flight attitude from which the aircraft cannot be recovered.

The ADI operates on 115 volt ac power from the essential ac bus.

Horizontal Situation Indicator.

The horizontal situation indicator (HSI) (figure 1-32) is a remote indicating instrument which displays course, heading, distance, and bearing information. The indicator includes a compass card, course and heading set knobs, course arrow, to-from indicator, lubber lines, bearing pointer, course deviation indicator and scale, range indicator and course selector windows, warning flags, and an aircraft symbol. The compass card is servo-driven and receives magnetic heading signals directly from either the bomb nav system or auxiliary flight reference system. Aircraft heading or its reciprocal are read under an upper and lower lubber line. The aircraft symbol is fixed and is oriented to the nose of the aircraft. A heading set knob is provided to set a heading marker to the desired heading. Once it is set, the marker rotates with the compass card. A course set knob is provided to set the course arrow and digits in the course selector window to the desired course. Once set, the arrow will rotate with the compass card. The shaft of the course arrow provides course deviation indications. The reciprocal course may be read off the tail of the arrow. An unreliable course signal or loss of the course signal to the indicator will cause a warning flag to appear in the upper center of the indicator. The bearing and distance to TACAN stations are displayed by the bearing pointer and range indicator window. Loss of the TACAN signal or an unreliable signal will cause a range warning flag to appear in the range indicator window. Loss of power to the HSI will cause an OFF warning flag to appear on the right side of the instrument. (Refer to "Instrument System Coupler Mode Selector Knob", this section, for HSI indications during various modes of operation.) The HSI operates on 115 volt ac power from the ac essential bus.

Instrument System Coupler Pitch Steering Mode Switch.

The instrument system coupler pitch steering mode switch (12, figure 1-6), located on the instrument system coupler control panel, is a three-position switch marked ALT REF (altitude reference), OFF, and TF (terrain following). The switch is solenoid held in either the ALT REF or TF position, when used with a compatible position of the instrument system coupler mode selector knob. When the switch is placed in the ALT REF position, pitch steering commands, referenced to the pressure altitude at the time the switch is engaged, will be displayed on the pitch steering bars on the attitude director indicator (ADI) and optical display sight (ODS). The ALT REF position is compatible with all positions of the instrument system coupler mode selector knob except TKR RV; however, when making an ILS or AILA approach, the switch will automatically return to OFF when the glide slope is intercepted. The switch will not hold in the ALT REF position if either TFR channel is in the TF mode and is operating normally. When the switch is placed to the TF position, pitch steering commands referenced to the altitude setting of the terrain following radar will be displayed on the pitch steering bars on the ADI and ODS. The TF position is compatible with all positions of the instrument system coupler mode selector knob except ILS, AILA, and TKR RV. However, with the knob in CRS SEL NAV, BOMB/NAV and CRS LINE position, the switch will return to OFF when a weapon delivery pull-up signal is generated.

Note

Altitude reference sub-mode limits are ± 500 feet from the reference pressure altitude. If the set limits are exceeded, the reference altitude will change by the amount that the altitude limits are exceeded.

Instrument System Coupler Mode Selector Knob.

The instrument system coupler mode selector knob (12, figure 1-6), located on the instrument system coupler control panel, has eleven positions. Ten positions of the knob are activated and are marked OFF, ILS, AILA, TACAN, CRS SEL NAV, BOMB/NAV, CRS LINE, MAN CRS, MAN HDG, and TKR RV. An unmarked position is provided for the installation of new equipment. The knob must be depressed to change positions. For instrument system coupler modes versus ADI and HSI indications refer to figures 1-34 and 1-35. For ADI and HSI steering indication limits refer to figure 1-36. The knob positions provide the following functions:

In the OFF position, the steering bars and OFF flags are biased out-of-view on the ADI and ODS leaving attitude and heading displays for use during GCA and other similar type operations.

The ILS (instrument landing system) position provides the capability of flying ILS approaches to runways equipped with localizer and glide slope transmitters. Localizer steering commands are displayed by the bank steering bars on the attitude indicator (ADI) and ODS and course deviation information is displayed on the course deviation indicator of the horizontal situation indicator (HSI). Pitch steering commands will be displayed on the pitch steering bars on the ADI and ODS if the pitch steering mode switch is in the ALT REF position. When the glide slope beam is intercepted the pitch steering mode switch, if on, will return to OFF and glide slope steering commands will then be displayed on the pitch steering bars on the ADI and ODS and glide slope deviation will be displayed on the ADI glide slope deviation indicator and on the left deviation indicator on the ODS.

Note

- Once the glide slope is intercepted, a glide slope deviation of more than two dots as measured on the glide slope deviation scale will cause the pitch steering bar on the ADI and ODS to drive out of view and remain out of view until the aircraft is repositioned back on the glide slope.
- Also at glide slope intercept the bank steering bar reference is switched from normal (25 degrees) to approach reference (15 degrees). Refer to figure 1-36.

With the radar altimeter operating and set for a minimum altitude penetration, the pitch steering bars on the ADI and ODS will indicate a fly-up command and the radar altitude low warning lamp will light when the aircraft penetrates the set altitude. If a pull-up is then initiated, the fly-up command will be terminated and the warning lamp will go out when the aircraft is above the altitude set on the radar altimeter. The pitch steering bar commands will be regained once the glide slope indicator is recentered or by placing the pitch steering mode switch to ALT REF when level off altitude is reached. In the event an ILS approach or AILA is begun from above 5000 feet absolute altitude the radar altitude low warning lamp will light and the pitch steering bars on the ADI and ODS will momentarily indicate a fly-up command when the aircraft descends through 5000 feet. In this case the fly-up command can be terminated and the lamp will go out by taking the above action.

The AILA (airborne instrument low approach) position provides the capability of making instrument letdowns and approaches to runways not equipped with ground based letdown systems. The bomb/nav system in conjunction with the attack radar is used to correct the present position longitude and latitude and will furnish simulated localizer and glide slope information to provide the same indications on the ADI, ODS, and HSI as when using the ILS position.

Note

During AILA approaches, when the bomb nav system is furnishing simulated localizer, the pitch steering bar will be stowed if the deviation from the simulated localizer exceeds ± 2.5 degrees or if glide slope deviation exceeds ± 0.9 degrees (2 dot glideslope deviation equals 0.7 degrees).

The TACAN (tactical air navigation) position provides the capability of making instrument approaches and flying a selected course to or from a TACAN station. The course arrow and the course selector window are set to the desired course to be flown using the course set knob. Course steering commands are displayed on the bank steering bars on the ADI and ODS and course deviation information is displayed on the course deviation indicator and bearing pointer on the HSI. Distance from the TACAN station is displayed in the range indicator window on the HSI. The bearing pointer will indicate the magnetic bearing to the station.

Note

The flight director computer is limited to a 40 degree bank angle.

The CRS SEL NAV (course select navigation) position provides the capability of approaching a selected destination along a selected course other than the most

ISC Mode Selector Knob Positions vs ADI Indications

ISC MODE SELECTOR KNOB POSITIONS

<table>
<tr><th></th><th>OFF</th><th>ILS</th><th>AILA</th><th>TACAN</th><th>CRS SEL NAV</th><th>BOMB/ NAV</th><th>CRS LINE</th><th>MAN CRS</th><th>MAN HDG</th><th>TKR/ RV</th></tr>
<tr><td>Bank Steering Bar</td><td>Out of View</td><td>Steer to Loc</td><td>Com steer fr B/N to set crs</td><td>Steer to TACAN crs</td><td>Com steer fr B/N to set crs</td><td>Com steer to dest</td><td>Com steer to crs line</td><td>Com steer to selected crs</td><td>Hdg fr HSI and FDC</td><td>Target steer fr attack radar</td></tr>
<tr><td>Pitch Steering Bar</td><td>Out of View</td><td colspan="2">In view in alt ref and when G/S beam inter</td><td colspan="6">Out of view unless TF or ALT REF is selected (Note 2)</td><td>Target elev fr attack radar</td></tr>
<tr><td>Heading Reference Scale</td><td colspan="10">Mag hdg from B/N or mag hdg from AFRS if pri hdg caution lamp is lighted, or mode selector knob is in TACAN or TKR RV.</td></tr>
<tr><td>Attitude Sphere</td><td colspan="10">Pitch and roll from B/N system when selected, or from the AFRS when PRI ATTITUDE caution lamp is lighted, or AUX is selected. ★</td></tr>
<tr><td>Glide Slope Indicator</td><td>Out of View</td><td>G/S fr G/S rec</td><td>Dev fr set G/S fr B/N</td><td colspan="7">—Out of View—</td></tr>
<tr><td>Course Warning Flag</td><td>Out of View</td><td>Out of view when loc adeq sig stren</td><td>Out of view loc valid fr B/N</td><td>Out of view when TACAN adeq sig stren</td><td colspan="4">Out of view when lateral steering is valid fr B/N</td><td>Out of view</td><td>Out of view</td></tr>
<tr><td>Glide Slope Warning Flag</td><td>Out of View</td><td>Out of view when G/S adeq sig stren</td><td>Out of view when dev fr G/S is valid</td><td colspan="7">—Out of View—</td></tr>
<tr><td>Attitude Warning Flag</td><td colspan="10">Normal condition—Out of view.
Abnormal condition—In view, disregard ADI and use stby att ind for attitude and ODS for pitch and azimuth steering.</td></tr>
<tr><td>ISC Pitch Steer Sw</td><td>TF or ALT REF</td><td colspan="3">ALT REF prior to G/S (Note 1)</td><td colspan="5">(Note 2)
TF or ALT REF</td><td>Not Useable</td></tr>
<tr><td colspan="11">Note 1: ALT REF is useable prior to intercepting G/S. When G/S is intercepted the ALT REF is automatically disengaged by the FDC in ILS or B/N in AILA mode.
Note 2: TF or ALT REF is automatically disengaged by the pull up signal from the bomb navigation set when in LADD weapon delivery mode, and a command pull up is displayed on the ADI and ODS.</td></tr>
</table>

Figure 1-34.

ISC Mode Selector Knob Positions vs HSI Indications

ISC MODE SELECTOR KNOB POSITIONS

	OFF	*ILS*	*AILA*	*TACAN*	*CRS SEL NAV*	*BOMB/ NAV*	*CRS LINF*	*MAN CRS*	*MAN HDG*	*TKR RV*
Course Set Knob	Not Used	Used to set ldg approach crs in crs set window		Used to set TACAN crs	Used to set desired crs	Not Used	Not Used	Used to set des crs	Not Used	
Heading Set Knob	—Not Used—								Used to set desired mag hdg	Not Used
Compass Card	Heading fr B/N sys when sel, or mag hdg fr the AFRS when pri hdg caution light is lighted or AUX is sel, except TACAN or TKR RV modes which uses AFRS mag hdg only. (Note 1)									
Course Select Window & Course Arrow	Mag grd track fr B/N	Ldg approach crs man set by the crs set knob		TACAN crs man set	Desired crs man set	Cur grd trk	Cur grd trk	Fix at last set pos	Ground track from B/N	
Course Deviation Indicator	Not Used Ctr	Loc dev fr loc rec	Loc dev fr B/N	TACAN dev fr sel crs	Lateral dev fr B/N				Not Used—Center	
Heading Marker	Indicates computed course from B/N.								Mag hdg man set	Bearing to tkr fr attack radar
Course Deviation Bar Flag	Out of view			Out of view by TACAN	Out of view by B/N				Out of view by FDC	
Power Off Warning Flag	Normal Condition—Out of view. Abnormal Condition—When in view, disregard HSI and ADI in MAN/HDG mode and use BDHI or ODS.									
Range Ind and Warning Flag	Indicates distance to TACAN station.									
Bearing Pointer (TACAN)	Indicates bearing to TACAN station.									
To—From Indicator (TACAN)	Out of view—Not Used			To or fr TACAN sta	Out of view—Not Used					

Note 1: Primary mag heading display will be true heading plus or minus mag variation.

Figure 1-35.

HSI and ADI Steering Limits

	ILS		*AILA*			*CRS SEL*						*ALT REF*
	Norm.	*Appr.*	*Norm.*	*Appr.*	*TACAN*	*NAV*	*BOMB NAV*	*CRS LINE*	*MAN CRS*	*MAN HDG*	*TKR RV*	*Sub Mode*
2 Dot Displ of (HSI) CRS DEV IND	2.5°	2.5°	2.5°	2.5°	10°	10°	Nav 10° Bomb 2.5°* 5.0°† ★	10°	10°	Not Used	Not Used	Not Used
2 Dot Displ of ADI G/S DEV IND	0.7°	0.7°	0.7°	0.7°	Not Used							
ADI Bank Steering Pointer Roll Limit	25°	15°	30°	15°	40°	30°	Nav 30° Bomb 42°	30°	30°	25°	60°	
ADI Pitch Steering Pointer Pitch Limit	20°	20°	20°	20°	Not Used						20°	20°

Specified limits are established by the flight director computer and the applicable sub-system supplying the signals and are not affected by the ODS.
*Prior to T.O. 1F-111(B)A-651 ★
†After T.O. 1F-111(B)A-651

Figure 1-36.

direct route. This provides the capability of avoiding weather, obstacles, and enemy areas. To commence the course select navigation procedure, depress the destination selected sequence point pushbutton, select CRS SEL NAV on the instrument system coupler and set the selected course in the HSI course selector window. This establishes a course signal to the bomb nav system where a course error signal is developed. When the selected course is set in the HSI, a right or left steering signal is generated for the ADI and ODS bank steering bars. This signal depends on (1) aircraft position in relation to selected course, and (2) aircraft ground track in relation to the ground track required to make good on approach flight path. The HSI course deviation bar will be displaced two dots until within 10 degrees of the selected course. To intercept the selected course at a predetermined position it is necessary to maintain the bank steering bars centered. When the aircraft is on the selected course the heading marker and course arrowhead will be aligned ± drift correction.

The BOMB/NAV (bombing navigation) position provides steering information from the bomb nav system to steer the aircraft to a weapon release point or to a selected destination depending on a position of the bomb nav function select knob. When the bomb nav function select knob is in the BOMB RADAR or NAV positions course steering commands are displayed on the bank steering bars on the ADI and ODS and course deviation is displayed on the course deviation indicator on the HSI. The course set knob and the heading set knob are inoperative in the BOMB/NAV mode. The course arrow and course selector window display current magnetic ground track from the bomb nav system.

The CRS LINE (course line steering) position provides steering commands to steer the aircraft along the computed great circle course between the past destination and the current destination. If the aircraft deviates from this computed great circle course, this mode will provide steering commands to return to course by the shortest route.

The MAN CRS (manual course) position provides the capability of flying a manually selected course instead of a bomb nav system computed course. This position can be utilized to fly a constant course while taking a fix, changing destination, or working a navigation problem. The desired course is set in the course selector window of the HSI. The selected course is compared with actual course by the bomb nav system, and an error signal is provided to display course steering commands on the bank steering bars on the ADI and ODS and course deviation information on the course deviation indicator on the HSI.

The MAN HDG (manual heading) position provides the capability of flying any desired heading when use of the bomb nav system is impractical or inefficient or when the system is inoperative. The heading marker on the HSI is set to the desired heading on the compass card by using the heading set knob. Turn the aircraft to center the bank steering bars on the ADI and ODS. Any deviation from this heading will generate a steering command on the bank steering bars on the ADI and ODS. If the bomb nav system is inoperative, the course set knob should be used to set the desired heading in the course selector window. This will provide a digital readout of the heading and align the course arrow with the heading marker to reduce the possibility of heading confusion.

The TKR RV (tanker rendezvous) position provides the steering capability to a tanker for air refueling rendezvous. In this mode the HSI heading marker is driven by a bearing signal from the attack radar which also supplies a signal to indicate the necessary steering commands on the bank steering bars on the ADI and ODS to steer the aircraft to the tanker.

Note

The bank steering bars on the ODS and ADI will oscillate after the attack radar locks on the tanker signal. This is normal and is due to the automatic angle tracking of the radar. The amplitude of the oscillation will increase as the range is decreased; however, the frequency of the oscillation will remain constant.

The pitch steering bars on the ADI and ODS will be activated and indicate the necessary pitch steering correction (aircraft angle of attack plus radar antenna tilt angle) to rendezvous with the tanker.

Instrument Test Button.

The instrument test button (7, figure 1-27), located on the ground check panel, is provided for ground checking and troubleshooting of the integrated flight instruments, the instrument system coupler, the attitude monitor system, and the total temperature indicator. Depressing and holding the button will provide a set of predetermined indications on the above instruments. Test indications on the ADI and HSI will be compatible with the normal indications expected for each mode selected by the instrument system coupler mode selector knob. Tests selected with the button are completely independent of the CADC.

Note

After T.O. 1F-111(B)A-637, the attitude monitor system is also checked by the instrument test button. Refer to "Attitude Monitor System," this section.

ATTITUDE MONITOR SYSTEM.

After T.O. 1F-111(B)A-637, an attitude monitor system is provided. This system consists of a monitor unit installed behind the main instrument panel and an attitude caution lamp on the main caution lamp panel (figure 1-29). The attitude monitor system provides an indication of the reliability of the ADI, and the aircraft pitch and roll data signals to the ADI and the standby attitude indicator. With power on the aircraft, the attitude monitor system continuously compares these signals and also monitors the voltage to the ADI attitude warning flag. If either the pitch or roll signals to the ADI differ from those to the standby attitude indicator by more than 7 (±1.4) degrees or if the ADI attitude warning flag comes into view, a caution lamp will light. When the lamp is lighted, the word ATTITUDE is visible. The instrument test button is used to test the function of the attitude monitor unit. When the button is depressed, the ADI attitude warning flag will come into view and the attitude caution lamp will light.

Note

When operating on emergency generator power, the attitude monitor system may not be fully operable and the attitude lamp may not light; however, the ADI attitude warning flag and the attitude lamp, if lighted, should be considered valid.

COMMUNICATION EQUIPMENT.

For a listing and function of communications equipment see figure 1-37.

UHF COMMAND RADIO (AN/ARC-109).

The UHF command radios provide air-to-air and air-to-ground communications. Two complete UHF communication sets are installed in the aircraft and are designated No. 1 and No. 2. Each system consists of a receiver-transmitter (RT) unit, a control panel, an antenna selector, and blade type upper and lower antennas. See figure 1-55 for antenna locations. The two RT units and guard receiver are located in the right forward equipment bay. Both radio sets may be operated simultaneously except for transmission on the same channel, where interference between sets occurs. There are 3500 channels available in 50 kilohertz increments in the frequency range from 225.00 to 399.95 megahertz .The guard receiver monitors the guard frequency of 243.0 megahertz when guard function is selected. The control panel allows selection of 20 preset channels and manual selection of any frequency in the frequency range of the radio. The upper and lower antenna complement each other to provide omni-directional antenna coverage. An automatic feature allows the receiver

Communications and Avionics Equipment

Type	Designation	Function	Operator	Range
UHF RADIO	AN/ARC-109	Air-to-air and air-to-ground voice communication	Both	Line-of-Sight
HF RADIO	AN/ARC-123	Air-to-air and air-to-ground long range voice communications	Right	5000 miles
RADIO BEACON SET	AN/URT-33	Provides a tone signal for rescue aircraft to home on	Both	Line-of-Sight
INTERPHONE	AN/AIC-25	Interphone between crew members and monitoring of all communications facilities	Both	
IDENTIFICATION RADAR (IFF-SIF)	AN/APX-64	Provides coded IFF replies to an interrogating ground radar station	Right	Line-of-Sight
TACAN	AN/ARN-52	Provides bearing and distance informaton to TACAN stations	Both	Line-of-Sight up to 300 NM
ILS	AN/ARN-58A	Provides visual indications for ILS approaches	Left	Localizer 45 NM Glide Slope 25 NM
RADAR ALTIMETER	AN/APN-167	Provides precise altitude measurements from 0 to 5000 feet	Left	0-5000 feet
TERRAIN FOLLOWING RADAR	AN/APQ-134	Provides all weather, low altitude terrain following, obstacle avoidance and blind letdown capability	Left	Line-of-Sight up to 15 miles
BOMBING-NAVIGATION SYSTEM	MARK II B	Provides integrated bombing and navigation capabilities in conjunction with other systems in the aircraft	Right	
ATTACK RADAR	AN/APQ-114	All weather navigation, fix-taking, bombing, and tanker rendezvous	Right	Line-of-Sight up to approximately 200 miles
RADAR TRANSPONDER	AN/APX-78	Provides air-to-air and -air-to-ground range and bearing determination	Right	Line-of-Sight up to approximately 200 miles
OPTICAL DISPLAY SIGHT	AN/ASG-25	Provides tanker rendezvous and air-to-ground attack capability and duplicate information as displayed on ADI for instrument flying	Left	Line-of-Sight

Figure 1-37.

to select the antenna which receives the first usable signal; however, either the upper or lower antenna may be manually selected.

Note

> When operating the UHF in the automatic antenna selection mode, the antenna selector has a transmission memory circuit which automatically connects the transmitter to the antenna last used for transmission. If the channel or frequency is changed to another station or the aircraft position has changed relative to the station, this may be the wrong antenna for the next transmission and difficulty will be encountered in gaining contact. Should this occur, manually select the upper or lower antenna and repeat the transmission to gain contact.

The UHF-1 shares the same antennas with the TACAN and UHF-2 shares with the IFF. Number 1 UHF operates on 115 vac from the essential ac bus and 28 vdc from the essential dc bus. Number 2 UHF operates on 115 vac from the left main ac bus and 28 vdc from the main dc bus.

UHF Radio Function Selector Knob.

The UHF radio function selector knob (4, figure 1-38), located on the UHF radio control panel, has four positions marked OFF, MAIN, BOTH, and ADF. Rotating the knob to the MAIN position activates the RT unit for normal transmission and reception on the channel selected; the guard receiver is inoperative. Rotating the knob to the BOTH position also activates the RT unit for normal use and in addition activates the guard receiver to allow monitoring guard frequency. The ADF position is inoperative and should not be selected.

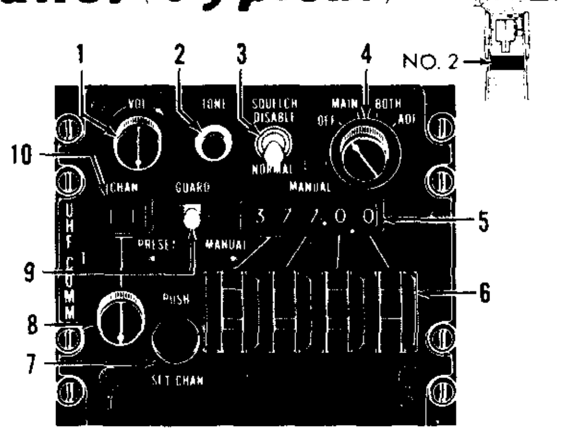
UHF Radio Mode Selector Switch.

The three position UHF radio mode selector switch (9, figure 1-38), located on the UHF radio control panel, permits selection of the desired operating mode. The switch is marked PRESET, MANUAL, and GUARD. The PRESET position is used when selecting one of the 20 preset frequencies. The MANUAL position is used when utilizing frequencies that are selected by the manual frequency selector knobs. The GUARD position tunes the main RT unit to the guard frequency of 243.0 megahertz.

UHF Radio Preset Channel Selector Knob.

The preset channel selector knob (8, figure 1-38), located on the UHF radio control panel, permits selection of one of twenty preset frequencies. With the mode selector switch in PRESET, movement of the preset channel selector knob changes the frequencies to that of the channel selected. There are 20 channels, numbered 1 through 20, that may be individually selected. The number of the channel selected is displayed in a window above the knob. Frequencies for each channel are written on a channel frequency log located under the pilot's glare shield. Frequencies of the preset channels can be changed during flight.

UHF Radio Control Panel (Typical)



1. Volume Control Knob.
2. Tone Button.
3. Squelch Switch.
4. Function Selector Knob.
5. Frequency Indicator Window.
6. Manual Frequency Selector Knobs (4).
7. Channel Set Pushbutton.
8. Preset Channel Selector Knob.
9. Mode Selector Switch.
10. Preset Channel Indicator Window.

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Figure 1-38.

UHF Radio Manual Frequency Selector Knobs.

Four thumb actuated UHF radio manual frequency selector knobs (6, figure 1-38), located on the UHF radio control panel, are provided for manually selecting frequencies. Manual frequency selection can be made in steps of 50 kilohertz from 225 through 399.95 megahertz. The first selector knob will select the first two digits of the desired frequency. The second, third and fourth knobs select the third, fourth and fifth frequency digits respectively. The selected frequency is displayed in a window on the face of the UHF radio control panel.

UHF Radio Volume Control Knob.

The volume control knob (1, figure 1-38), located on the UHF radio control panel, increases the volume of the receiver when turned clockwise and decreases it when turned counterclockwise.

Squelch Switch.

The squelch switch (3, figure 1-38), located on the UHF radio control panel, is a two-position switch marked DISABLE and NORMAL. The switch is provided so that the squelch can be selected for compatibility with the strength of the signal being received. Placing the switch to DISABLE turns off the squelch. Placing the switch to NORMAL turns the squelch on.

Tone Button.

The tone button (2, figure 1-38), is located on the UHF radio control panel. With the UHF radio in operation, depressing the button will interrupt reception and transmit a continuous wave (CW) 1000 Hz tone signal on the selected frequency.

Channel Set Pushbutton.

The channel set pushbutton (7, figure 1-38), located on the UHF radio control panel, is used to set or change preset channel frequencies. The button is only effective when the mode selector switch is in the PRESET position. With the mode selector switch in the PRESET position and with the preset channel selector knob set to the desired channel, depressing the button will set the frequency selected in the manual frequency window into the desired channel. The button is recessed in a guard to prevent inadvertent actuation.

Transmitter Selector Knobs.

Two transmitter selector knobs (3, figure 1-40), labeled INT, UHF-1, UHF-2 and HF, are located on the left and right communications control panels to select either the UHF or HF radio or interphone as desired for transmission.

Microphone Switches.

A three position spring loaded, pivot type microphone switch marked TRANS and INPH with an unmarked off center position, is located on each right throttle (5, figure 1-5). It is spring loaded to the center OFF position.

UHF Radio Antenna Selector Switches.

Two, three position UHF radio antenna selector switches (1 and 2, figure 1-45), located on the antenna select panel are labeled UHF-1 and UHF-2. The switches are marked UPPER, AUTO, and LOWER and control the selection of upper and lower antennas. Placing the switch to AUTO causes the antenna selector to control the antenna switching relay to select the correct antenna. Placing the switch in the LOWER or UPPER position controls the antenna relay directly to allow manual selection of either the upper or lower antenna.

UHF Radio Frequency Indicator Window.

The UHF radio frequency indicator window (5, figure 1-38), located on the UHF radio control panel, indicates the frequency selected for transmission or receiving. The window has five digits, which are set by frequency selector knobs below the window.

HF RADIO (AN/ARC-123).

Aircraft 27 ▶ and those modified by T.O. 1F-111-863 are equipped with an AN/ARC-123 radio. The HF radio provides long range high frequency single side-band air-to-air and air-to-ground communications. The radio operates in three modes: SSB, single side band; AME, amplitude modulation equivalent, and FSK, frequency shift keying. The FSK position is inoperative at this time. There are 280,000 channels available in 100 Hz increments in the frequency range of 2000 through 29,999.9 kilohertz. Components of the system include a receiver-transmitter (RT) unit, amplifier power supply, control panel, antenna, coupler, antenna coupler control, and remote capacitor. The RT unit, amplifier power supply and antenna coupler controls are located in the right forward electronic bay. The antenna coupler is located in the aft fuselage below the antenna which is a part of the vertical stabilizer and dorsal fin. The remote capacitor is located at the forward tip of the dorsal fin. Refer to figure 1-55 for antenna location. The antenna is impedance matched to the receiver-transmitter. The system incorporates self test features for maintenance troubleshooting. The control panel is located at the right crew station on the right console. Once the system is placed in operation either crew member can use the equipment. The radio operates on 115 volt ac power from the right main ac bus.

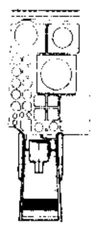
HF Radio Mode Selector Knob.

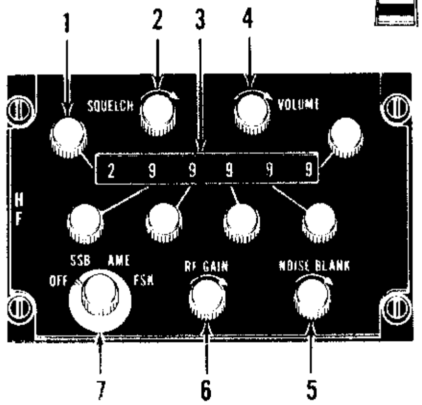
The HF radio mode selector knob (7, figure 1-39), located on the HF radio control panel has four positions marked OFF, SSB, AME and FSK. In the OFF position the system is deenergized. Rotating the knob to SSB, provides single side band capability of operation. The AME position provides the capability of amplitude modulation equivalent capability of operation. The FSK position is inoperative at this time.

HF Radio Frequency Selector Knobs.

Six HF radio frequency selector knobs (1, figure 1-39), located on the HF radio control panel, provide a means of setting desired frequencies. Each knob has an indicator line drawn to the window it controls on the frequency indicators. To prevent selection of frequencies below 2000 KHz, the 1000 KHz and 10,000 KHz knobs are interlocked. In order to select 0 with the 10,000 KHz knob, a 2 through 9 must be present in the 1000 KHz window. In order to select a 1 or 0 with the 1000 KHz knob, a 1 or 2 must be present in the 10,000 KHz window.

HF Radio Control Panel





1. Frequency Selector Knobs (6).
2. Squelch Control Knob.
3. Frequency Indicator Window.
4. Volume Control Knob.
5. Noise Blanking Control Knob.
6. RF Gain Control Knob.
7. Mode Selector Knob.

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Figure 1-39.

HF Radio Frequency Indicator Window.

The HF radio frequency indicator window (3, figure 1-39), located on the HF radio control panel, has six digits indicating the frequency selected for transmission or receiving. Each window has an indicator line drawn to its corresponding frequency selector knob.

RF Gain Control Knob.

The radio frequency gain control knob (6, figure 1-39), located on the HF radio control panel is labeled RF GAIN. The knob is used to adjust the radio frequency gain of the receiver as desired during normal operation, to provide better signal to noise ratio.

Note

The RF GAIN control knob should not be used for adjusting the audio volume.

Noise Blanking Control Knob.

The noise blanking control knob (5, figure 1-39), located on the HF radio control panel is labeled NOISE BLANK. The knob is used to reduce the effects of impulse noise, either natural or man-made, including ECM.

Note

Adjustment of the noise blanking control knob is not critical. If high impulse noise is encountered, rotation of the knob will blank the noise without affecting voice signals.

Volume Control Knob.

The volume control knob (4, figure 1-39), located on the HF radio control panel, is labeled VOLUME. When the knob is rotated clockwise the audio output is increased.

Note

- For most applications the volume control knob should be set to obtain approximately the same audio level as the UHF to balance the audio out of the interphone. After this balance has been obtained, any addition audio volume corrections should be made with the interphone volume controls.
- Care should be exercised in the use of this control as audio can be disabled if this control is set too far counterclockwise.

Squelch Control Knob.

The squelch control knob (2, figure 1-39), located on the HF radio control panel, is labeled SQUELCH and is used to adjust the threshold of squelch operation in the SSB or AME mode. Adjustment of the squelch must be done after the other controls have been set. First place the squelch control fully clockwise. Then with no signal on the channel, turn the squelch control counterclockwise slowly until the noise is subdued. Rotate the control knob slowly clockwise and find the place where the set breaks in and out of squelch. This is the proper squelch adjustment for the prevailing noise conditions. If the noise conditions change, the squelch must be readjusted. If desired signals are found to break in and out of squelch, adjust to a higher clockwise position or operate without squelch.

Note

Care must be exercised in the use of this control as the receiver audio can be disabled if the squelch is set too far counterclockwise.

RADIO BEACON SET.

A radio beacon set, located behind the left seat (15, figure 1-77), is provided for use as a survival radio to aid in crew rescue after ejection. The radio operates on a self-contained battery. The set is connected to a crew module mounted antenna which is automatically

erected when the crew module ejects. An on-off switch on the face of the radio is provided to arm the set. A safety plug located adjacent to the on-off switch must be removed to place the set in operation. When the switch is positioned to ON and the safety plug removed, the radio will transmit an intermittent modulated tone signal for the rescue aircraft to home on. The radio can also be removed from the crew module and used as a portable rescue aid. A telescoping antenna, stowed in the radio, can be extended when the radio is used as a portable. When the on-off switch is placed to ON and the chaff control lever is ON, the radio will be automatically actuated whenever ejection occurs.

INTERPHONE (AN/AIC-25).

The interphone provides the following functions: Communications between crew members and between crew members and ground crew; monitoring and volume control UHF radio, HF radio, TACAN, ILS, RHAW and missile tone reception; and hot mic and call capability. Two identical communications panels (figure 1-40) are located on the left and right consoles. Interphone stations for ground crew operation are located in the nose wheel well, main landing gear well and in the ground power receptacle on aircraft 27 ➧ and those modified by T.O. 1F-111-677. The interphone operates on 28 volt dc power from the essential dc bus. Power is applied to the interphone whenever power is on the aircraft.

Communications Monitor Knobs.

Eight push-pull communication monitor knobs (1, figure 1-40), located on each communications panel, are marked and monitor the functions as follows:

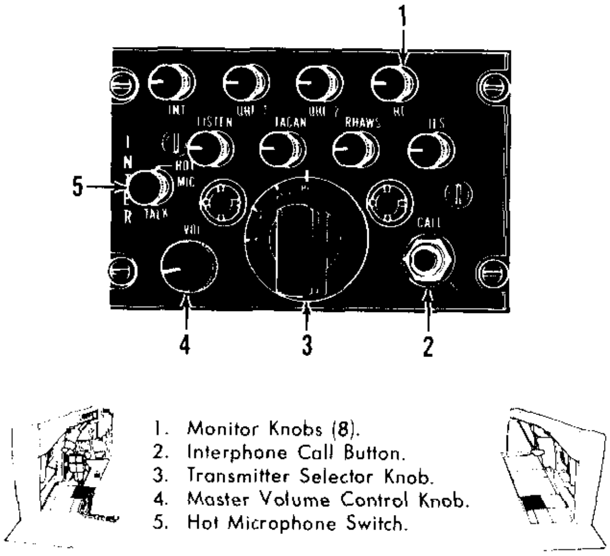
INT	— Interphone
UHF 1	— UHF Command Radio 1
UHF 2	— UHF Command Radio 2 and IFF mode 4
HF	— HF Radio
ILS	— ILS and Localizer or (after T.O. 1F-111-1074) TFR aural command
TACAN	— TACAN Identification
RHAWS	— Radar Homing and Warning System
LISTEN	— Hot Mic Monitoring

Other signals fed to the communications panel are the landing gear warning tone and the stall warning signal. The monitor knobs are pulled out to turn on and pushed in to turn off. When pulled out, each knob may be rotated for volume control.

Master Volume Control Knob.

A master volume control knob (4, figure 1-40), located on each communications panel, controls the volume of all inputs to the panel. If a change to an individual input volume is desired, it can be accomplished by rotating the appropriate monitor knob.

Communications Panel



1. Monitor Knobs (8).
2. Interphone Call Button.
3. Transmitter Selector Knob.
4. Master Volume Control Knob.
5. Hot Microphone Switch.

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Figure 1-40.

Hot Microphone Talk Buttons.

A push-pull (HOT MIC) hot microphone talk button (5, figure 1-40), located on each communications panel, provides a continually operating microphone when it is pulled. When this switch is pulled, the crew member can transmit without using the microphone switch, however, the crew member at each station must have his hot mic listen monitor buttons pulled to receive the transmission.

Note

The use of HOT MIC TALK when there is a high background noise level in the cockpit will interfere with UHF communications. Under these conditions, use of the INPH push-to-talk mode rather than HOT MIC TALK is recommended.

Interphone Call Button.

The interphone call button (2, figure 1-40), located on the communication panel, permits either crew member to call the other crew member or the ground crew. Depressing either call button boosts the inter-

phone volume of the other stations and reduces the operator's side tone level, allowing the call signal to override the other station's reception. The call signal will override the reception at the other station regardless of the position of the communications monitor knob or transmitter selector knobs at either station.

Transmitter Selector Knob.

Two seven-positon transmitter selector knobs (3, figure 1-40), located on each communications panel, are provided to select either UHF or HF radio. The knobs are marked INT, UHF 1, UHF 2, and HF. Three spare positions are unmarked. In either the HF or UHF positions only the radio transmitter selected will be keyed when the microphone switch is moved to the TRANS position. In addition, the UHF 1, UHF 2, or HF position will allow continuous monitoring of the respective receiver (UHF 1, UHF 2, or HF) regardless of the position of the communications monitor knob. Regardless of the position of the transmitter selector switch, the interphone may be used by moving the microphone switch on the throttle to the INPH position.

Microphone Switch.

A three position pivot type microphone switch, marked TRANS and INPH with an unmarked OFF position, is located on each right throttle (5, figure 1-5). The switch is spring loaded to the center OFF position. When the transmitter selector switch is in the INT position, moving the switch to either position allows interphone use.

Transmit Foot Switch.

A foot switch located by the right crew member's left foot is marked TRANSMIT. The switch is spring loaded to the off position and when depressed allows transmission without having to change the position of the transmitter selector knob.

Interphone Foot Switch

A foot switch located by the right crew member's right foot is marked INTERPHONE. The switch is spring loaded to the off position and when depressed allows interphone use.

Exterior Interphone Stations.

Exterior interphone stations in the nose wheel well and the main landing gear wheel well have a volume control knob, a call pushbutton, and a receptacle for ground cord plug in. The call pushbutton and volume control knob function the same as those controls on the interphone control panel. Aircraft 27 ♦ and those modified by T.O. 1F-111-677 have an additional exterior interphone station installed in the ground power receptacle.

I-BAND RADAR TRANSPONDER (AN/APX-78).

The I-band radar transponder enables ground and airborne I-band radar systems to identify and determine the range and bearing of the aircraft. The equipment consists of a radar transponder control panel, a radar transponder, a heat exchanger, and an I-band horizontally polarized antenna. The equipment does not perform interrogation but only transmits replies to selected interrogations. When interrogated by I-band pulses of the proper spacing, the radar transponder component transmits high level replies in the same frequency band. The I-band transponder is capable of replying to single or several spacings of double pulse interrogations, depending on the setting of the DECODE mode switch. The characteristics of the I-band transponder reply will be a single pulse or double pulse with several selections of spacing depending on the setting of the ENCODE mode switch.

ENCODE MODE SELECTOR KNOB.

The six position encode mode selector knob (1, figure 1-41), located on the radar transponder control panel, is marked 1 through 6. In position 1 the transponder will reply with a single pulse. In position 2 through 6 the transponder will reply with a pulse pair of the selected spacing when properly interrogated. The pulse spacing of the pulse pairs is as follows:

Encode Switch Position	*Pulse Spacing*
2	4 NM
3	6 NM
4	8 NM
5	10 NM
6	12 NM

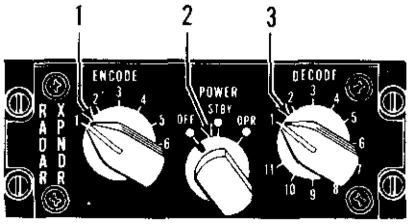
POWER SELECTOR KNOB.

The three position power selector knob (2, figure 1-41), located on the radar transponder control panel is marked OFF, STBY and OPR. When the knob is rotated to the OFF position the system is deenergized. When the knob is rotated to the STBY position power is supplied and the receiver is operational, but replies are inhibited. When the knob is rotated to OPR the system is operational and will respond to a proper interrogation. The I-band transponder will be operational within one minute after being changed from the OFF to OPR position and will meet all performance requirements within five minutes.

DECODE MODE SELECTOR KNOB.

The eleven position decode mode selector knob (3, figure 1-41), located on the radar transponder control

Radar Transponder Control Panel



1. Encode Mode Selector Knob.
2. Power Selector Knob.
3. Decode Mode Selector Knob.

F7211100-F004A

Figure 1-41.

panel is marked 1 through 11. When the knob is rotated to the number 1 position the transponder will respond to pulse combinations single or multiple in the proper radio frequency band. In positions 2 through 11 the transponder will respond to pulse pairs of the selected spacing.

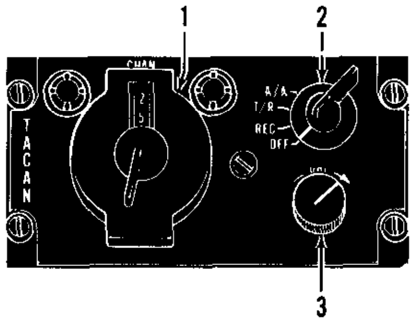
TACTICAL AIR NAVIGATION SYSTEM (AN/ARN-52).

The tactical air navigation system (TACAN) enables the aircraft to display continuous indications of its distance and bearing from any selected TACAN station located within a line-of-sight distance. There are 126 channels available for selection. The equipment consists of the TACAN receiver-transmitter and its control panel. Two antennas, one on top of the fuselage and the other beneath the fuselage (figure 1-55), function to keep the TACAN receiver locked on to the antenna receiving a usable signal. The TACAN equipment also has an air-to-air mode and can be used between two aircraft having TACAN with air-to-air capability for range information only. The TACAN works in conjunction with the instrument system coupler, the bearing distance heading indicator, the optical display sight, the horizontal situation indicator, the attitude director indicator, and through the interphone control panel for audio output. The system operates on 28 volt dc from the main dc bus and 115 volt ac from the left main ac bus. The TACAN control panel is located on the center console.

TACAN FUNCTION SELECTOR KNOB.

The function selector knob (2, figure 1-42), located on the TACAN control panel, has four positions marked OFF, REC, T/R, and A/A. In the OFF position, electrical power to the TACAN system is off. In any of the other three positions, electrical power is supplied and the TACAN set is on. In the REC position, the set will receive bearing and audio identity signals only. In REC position, range information will not be displayed because the TACAN transmitter is not on. In the T/R position, both the receiver and the transmitter are operative, the system will receive and display both range and bearing of the station being interrogated, and audio identity signals are fed into the interphone system. In the A/A (air-to-air) position, the set will transmit and receive to and from another aircraft having air-to-air capability. To operate in this mode, the

TACAN Control Panel



1. Channel Selector.
2. Function Selector Knob.
3. Volume Control Knob.

F7111200-F001

Figure 1-42.

air-to-air mode in both aircraft must be selected and the channels selected must be 63 channels apart. As an example, if the TACAN in one aircraft is on channel 10, the TACAN in the other aircraft must be selected to channel 73. In the A/A mode, the TACAN will provide information for up to 5 aircraft to home on a single aircraft.

TACAN CHANNEL SELECTOR.

The channel selector (1, figure 1-42), located on the TACAN control panel, consists of inner and outer adjustment controls for selecting any one of the available 126 TACAN channels. The selected channel is digitally displayed on the selector. The outer control is used to select the first two digits of the desired channel and the inner control to select the last digit.

TACAN VOLUME CONTROL KNOB.

A volume control knob (3, figure 1-42), located on the TACAN control panel, provides a means for controlling the volume of the audio identity code.

TACAN ANTENNA SELECTOR SWITCH.

The three position TACAN antenna selector switch (3, figure 1-45), located on the antenna select panel, controls the selection of the upper and lower TACAN antennas. The switch is marked UPPER, AUTO and LOWER. Placing the switch to AUTO causes the antenna selector to control the antenna switching relay to select the correct antenna. Placing the switch to UPPER or LOWER controls the antenna relay directly to allow manual selection of either the upper or lower antenna.

TACAN OPERATION.

1. Function selector knob—As required (REC, T/R, or A/A).
2. Antenna selector switch—AUTO.
3. Channel selector—As required.
4. TACAN monitor knob—On, volume adjusted.
5. Volume control knob—Adjust to 12 o'clock position.
6. Instrument system coupler mode selector knob — TACAN.
7. Horizontal situation indicator (HSI) course selector window—Set.

   Set the desired TACAN course in the HSI course selector window.
8. Monitor ADI, ODS, HSI and BDHI for proper indications.

Note

It is possible that improperly adjusted or malfunctioning ground or airborne TACAN equipment may lock on to a false bearing. This error will probably be plus or minus 40 degrees or multiples of 40 degrees. This is an inherent error in the TACAN system, consequently, bearing information should be cross-checked against other navigation aids whenever possible. When false lock on occurs, it is possible to correct the malfunction by switching to another channel and back to the desired channel or turning the set off and back on again. This deficiency does not affect the range display.

INSTRUMENT LANDING SYSTEM (AN/ARN-58A).

The instrument landing system (ILS) provides the capability of making instrument approaches to runways equipped with localizer, glide slope and marker beacon equipment. The system consists of three receivers, one each for localizer, glide slope and marker beacon; four antennas, two for localizer and one each for glide slope and marker beacon, a control panel and a marker beacon light. The localizer and glide slope receivers operate on 20 fixed frequency channels which may be selected on the control panel. Glide slope frequencies are paired with localizer frequencies so that selection of a localizer channel automatically provides for glide slope reception. Localizer identification signals are supplied to the headset for station identification. Localizer and glide slope steering and deviation signals are provided to the instrument system coupler for display on the attitude director indicator (ADI), horizontal situation indicator (HSI) and optical display sight (ODS). Warning flags on the ADI become visible whenever the signal level on the selected frequency is too weak to be usable or is unreliable. Refer to "Instruments," this section, for the tie-in of the ILS and Integrated Flight Instruments. The marker beacon receiver operates on a fixed frequency of 75 megahertz and when over a beacon facility will provide a signal to the marker beacon lamp. Power is applied to the marker beacon receiver whenever power is on the aircraft. The ILS operates on 28 volt dc power from the dc main bus. Refer to Instrument Procedures, Section VII for instrument landing system operating procedures.

ILS FREQUENCY SELECTOR KNOB.

The frequency selector knob (2, figure 1-43), located on the ILS control panel, allows individual selection of 20 ILS channels ranging in localizer frequencies from 108.1 to 111.9 megahertz in 0.2 megahertz increments. There is a detent position of the knob for each channel.

One complete rotation of the knob covers the full range of frequencies. Each localizer frequency selected is paired with a glide slope frequency between 329.3 and 335.0 megahertz. The frequency of each channel selected is displayed in a digital window to the left of the knob.

ILS POWER SWITCH.

The power switch (3, figure 1-43), located on the ILS control panel, is a two position switch marked POWER and OFF. In the OFF position power is removed from the localizer and glide slope receivers. When the switch is placed to POWER, 28 volts dc power is applied to the localizer and glide slope receivers.

ILS VOLUME CONTROL KNOB.

The volume control knob (4, figure 1-43), located on the ILS control panel, adjusts the volume of the localizer station identification signal. Clockwise rotation increases volume.

MARKER BEACON LAMP.

The marker beacon lamp (15, figure 1-6), located on the left main instrument panel, provides a visual coded station signal when the aircraft is over a marker beacon facility. When lighted the words MARKER BEACON are displayed in green.

Note

The marker beacon lamp may blink during HF radio transmission on some frequencies due to electro magnetic interference. This is not a malfunction of either the marker beacon or HF radio and should be no cause for alarm.

IFF SYSTEM (AN/APX-64). (AIMS)

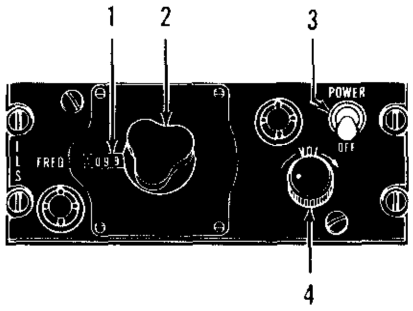
Note

AIMS includes the features of and is derived from:

- Air traffic control radar beacon system (ATCRBS)
- IFF (SIF)
- MK 12 IFF
- System

The air-to-ground IFF system provides for Mark X IFF with selective identification feature (SIF), automatic altitude reporting, and Mark XII (mode 4) encrypted IFF.

ILS Control Panel



1. Frequency Window.
2. Frequency Selector Knob.
3. Power Switch.
4. Volume Control Knob.

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Figure 1-43.

Operation is possible in any one of five modes, with the capabilities of I/P (identification of position) and emergency identification. The modes of operation have the following significance: Mode 1—Security Identity, Mode 2—Personal Identity, Mode 3/A—Traffic Identity, Mode 4—Encrypted Identity and Mode C—Altitude Interrogation. The equipment consists of an IFF control panel, a transmitter-receiver, a mode 4 computer, an antenna lobing switch, and two radiator-type antennas. The equipment does not perform interrogation but only transmits coded replies to correctly coded interrogations. Two blade type antennas, an upper and lower, are provided. See figure 1-55 for antenna locations. The lobing switch rapidly transfers contact of the transmitter-receiver from one antenna to the other. This constant alternation eliminates blank spots in the antenna pattern caused by aircraft structure. The receiver is sensitive to all signals within its frequency range; however, only those signals meeting the complete predetermined requirements of the code being used will be recognized and answered. Mode 2 and 4 code settings are set into the receiver-transmitter on the ground and thus are fixed for any one flight. Mode 1 and 3/A codes are set up at the control panel. All modes can be turned on or off at the control panel. Replies to modes 1, 2, 3/A, 4 and C interrogations, as

well as to I/P and emergency replies, are shown on the ground station equipment. The system will go to code 7700 in mode 3/A when operating in the emergency mode. In the case of the more complicated SIF codes, ground stations will use a plan position indicator (PPI) and letter symbol indicator to decode and indicate supplementary information, such as specific identification and location, and flight or aircraft conditions. The mode C provides altitude information from the CADC to the ground in 100 foot increments. An optional low sensitivity setting provision restricts sensitivity so that replies are made only to local interrogations. Electrical power is supplied to the IFF system from the 115 volt ac essential bus and the 28 volt dc essential bus.

IFF MASTER CONTROL KNOB.

The five-position IFF master control knob (4, figure 1-44) is located on the IFF control panel. The knob positions are marked OFF, STBY, LOW, NORM and EMER. The OFF position removes power from the set and also zeroizes mode 4 code settings. When positioned to STBY, the equipment is turned on and warmed up but will not transmit. When positioned to LOW, only local (strong) interrogations are recognized and answered. When positioned to NORM, full range recognition and reply occurs. Transmitted power from the IFF system is the same for both the LOW and NORM positions. The knob must be pulled outward to position it to EMER. When the knob is positioned to EMER, an emergency-indicating pulse group is transmitted each time a mode 1, 2, or 3/A interrogation is recognized.

IDENTIFICATION-OF-POSITION SWITCH.

The identification-of-position (I/P) switch (6, figure 1-44), located on the IFF control panel, is used to control transmission of I/P pulse groups. The switch has three positions marked MIC, OUT, and IDENT. When the switch is momentarily held in the spring loaded IDENT position, the I/P timer is energized for 15-30 seconds. If a mode 1, 2, or 3/A interrogation is recognized within this 15-30 second period, I/P replies will be made. When the switch is placed in the MIC position, the I/P pulse group will be transmitted in reply to a mode 1 or 3/A interrogation as long as a microphone switch is held to the TRANS position and for 15-30 seconds after the microphone switch is released. The transmitter selector knob, at the crew station being used, must be in the UHF position to allow transmission of I/P groups with the microphone switch. When the microphone switch is open, transmission of the I/P pulse groups will be withheld. Placing the switch to the OUT position prevents transmission of I/P groups.

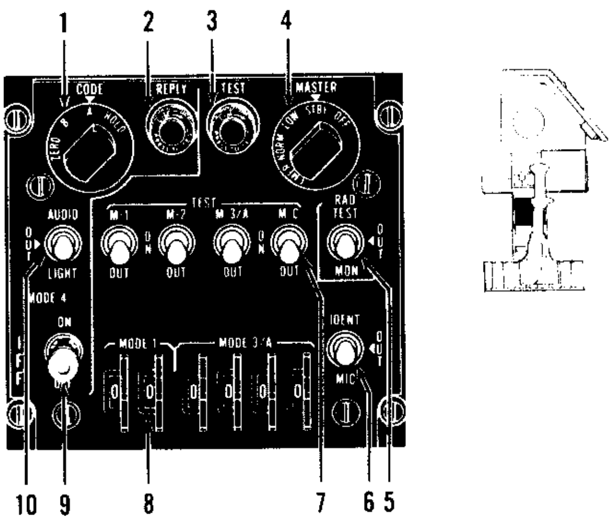
IFF ANTENNA SELECTOR SWITCH.

The two-position antenna selector switch (4, figure 1-45), located on the antenna select panel, is marked AUTO and LOWER. When the switch is placed to AUTO, the antenna lobing switch rapidly cycles contact of the receiver-transmitter between the upper and lower antenna to provide thorough antenna pattern coverage. When the antenna selector switch is placed to LOWER only, the lower antenna will be used to receive and reply to interrogation signals.

MODE SELECTOR/TEST SWITCHES.

Four mode select/test switches (7, figure 1-44), located on the IFF control panel, are marked TEST, ON and OUT. The switches are labeled M-1, M-2, M-3/A and M-C from left to right to correspond to mode 1, mode 2, mode 3/A and mode C. The OUT position for each switch disables the transmitter-receiver for the mode selected. The ON position for each switch enables the transmitter-receiver to reply to interrogations for the mode selected. If more than one switch is placed to ON the transmitter-receiver will reply to interrogations for all modes selected. The switches are spring-loaded to the ON position from the TEST position. The TEST positions are inoperative at this time.

IFF Control Panel

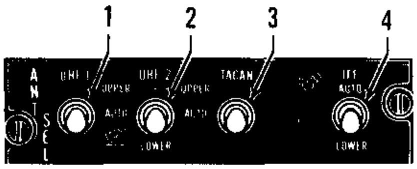


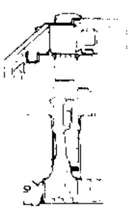
1. Mode 4 Code Control Knob.
2. Reply Lamp.
3. Test Lamp.
4. Master Control Knob
5. Rad Test/Monitor Switch.
6. Identification-of-Position Switch.
7. Mode Select/Test Switches (4).
8. Code Selector Wheels.
9. Mode 4 Control Switch.
10. Mode 4 Monitor Control Switch.

F6521200-F001

Figure 1-44.

Antenna Select Panel





1. UHF-1 Radio Antenna Selector Switch.
2. UHF-2 Radio Antenna Selector Switch.
3. TACAN Antenna Selector Switch.
4. IFF Antenna Selector Switch.

F6321600-F001A

Figure 1-45.

RAD TEST/MONITOR SWITCH.

The three position rad test/monitor switch (5, figure 1-44), located on the IFF control panel, is used for control of the radiation—test and monitor provisions. The switch has three positions marked RAD TEST, OUT and MON. The switch is spring-loaded from the RAD TEST to the OUT position. The MON position and in-flight test capability is inoperative at this time. When the switch is placed to OUT, the radiation test and monitor circuits are inoperative. The RAD TEST position is used for preflight check of the equipment.

CODE SELECTOR WHEELS.

Two sets of thumb actuated code selector wheels (8, figure 1-44), located on the IFF control panel, are provided to set mode 1 and mode 3/A codes. The set of wheels labeled mode 1 consists of two wheels which allow selection of 32 different codes. The set of wheels labeled mode 3/A consists of four wheels which provide the capability of setting 4096 codes. Code digits on each wheel are read in windows recessed in the face of the panel.

MODE 4 CONTROL SWITCH.

The mode 4 control switch (9, figure 1-44), located on the IFF control panel, has two positions marked ON and OUT. Mode 4 operation is enabled by placing the switch to ON. Placing the switch to OUT disables mode 4 operation. The switch toggle must be pulled out in order to move the switch between the ON and OUT positions.

MODE 4 CODE CONTROL KNOB.

The mode 4 code control knob (1, figure 1-44), located on the IFF control panel, has four positions marked ZERO, A, B, and HOLD. The knob must be pulled out before it can be moved to the ZERO position, and is spring-loaded from HOLD to the A position. Positions A and B select the preset code for the present and succeeding code periods, respectively. Placing the knob to ZERO will zeroize both code settings if the master control knob (4, figure 1-44) is in any position except OFF. Both codes will be automatically zeroized when the IFF is turned off after landing. However, both code settings can be retained by momentarily holding the knob in the spring-loaded HOLD position prior to turning the IFF off. The HOLD function is operative only when the landing gear handle is in the DN position, and requires that system power remain on for at least 15 seconds after HOLD is selected to allow mechanical latching of the code settings.

MODE 4 MONITOR CONTROL SWITCH.

The mode 4 monitor control switch (10, figure 1-44), located on the IFF control panel, has three positions marked AUDIO, OUT, and LIGHT. In the AUDIO position, monitoring of mode 4 interrogations and replies is provided by an audio tone on the interphone and by illumination of the reply lamp on the IFF control panel. The audio tone is controlled by the UHF-2 mixer switch on each communications panel. Placing the switch to LIGHT switches out the audio tone and provides monitoring only by the reply lamp. In the OUT position, both the audio tone and the reply lamp are inoperative.

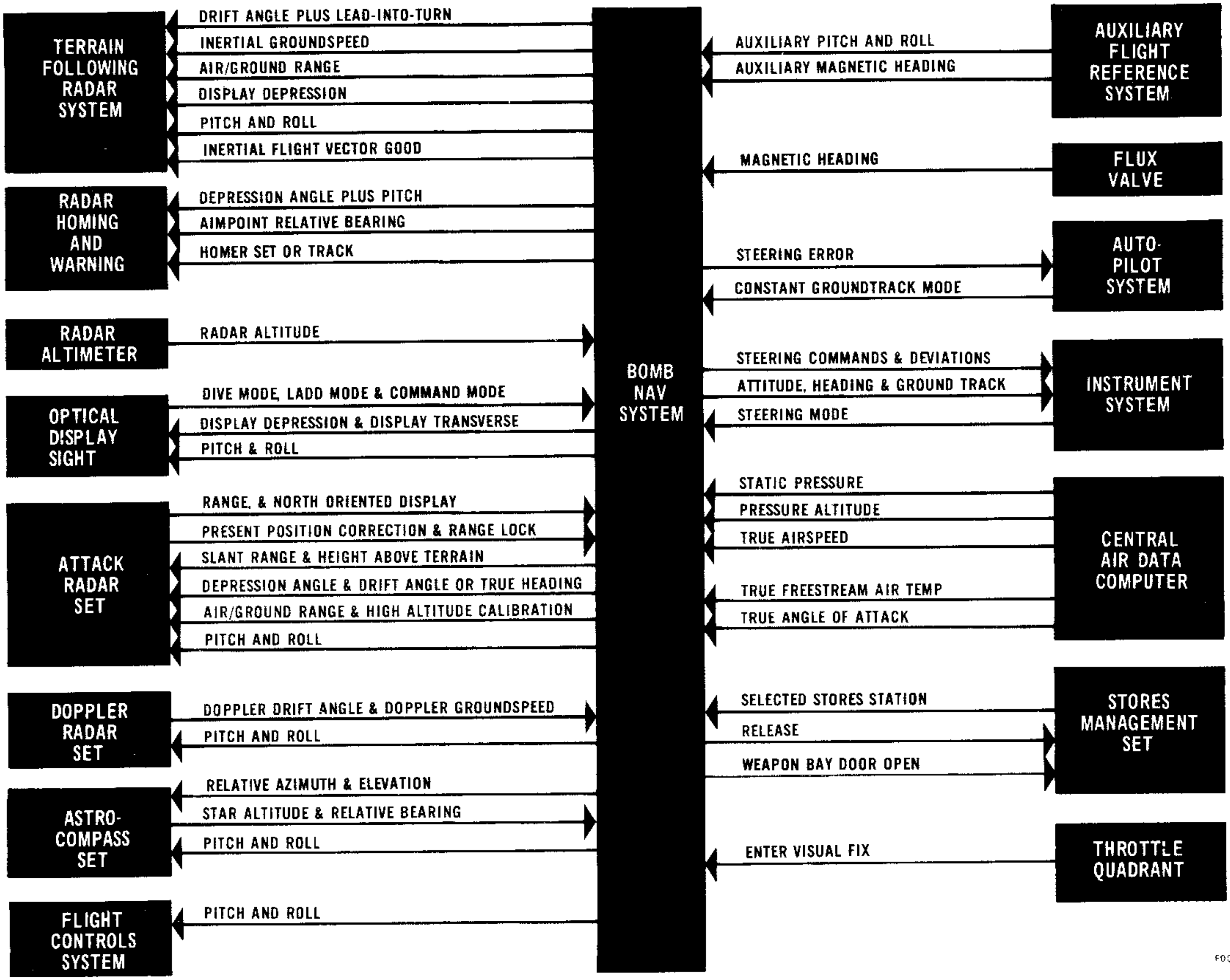
REPLY LAMP.

The reply lamp (2, figure 1-44), located on the IFF control panel, lights to indicate mode 4 replies. This lamp is operative only when the mode 4 monitor switch is in AUDIO or LIGHT.

IFF CAUTION LAMP.

The IFF caution lamp is located on the main caution lamp panel (figure 1-29). The lamp will light whenever an inoperative mode 4 capability is detected, provided the mode 4 computer is installed in the aircraft and the master control knob is not in the OFF position. Specific discrepancies monitored by the IFF caution lamp are:

Bomb Nav-Subsystem Tie-Ins



F0000000-F020

Figure 1-46.

- Mode 4 codes zeroized
- Failure of the system to reply to proper interrogation
- Automatic self-test function of the mode 4 computer reveals a faulty computer

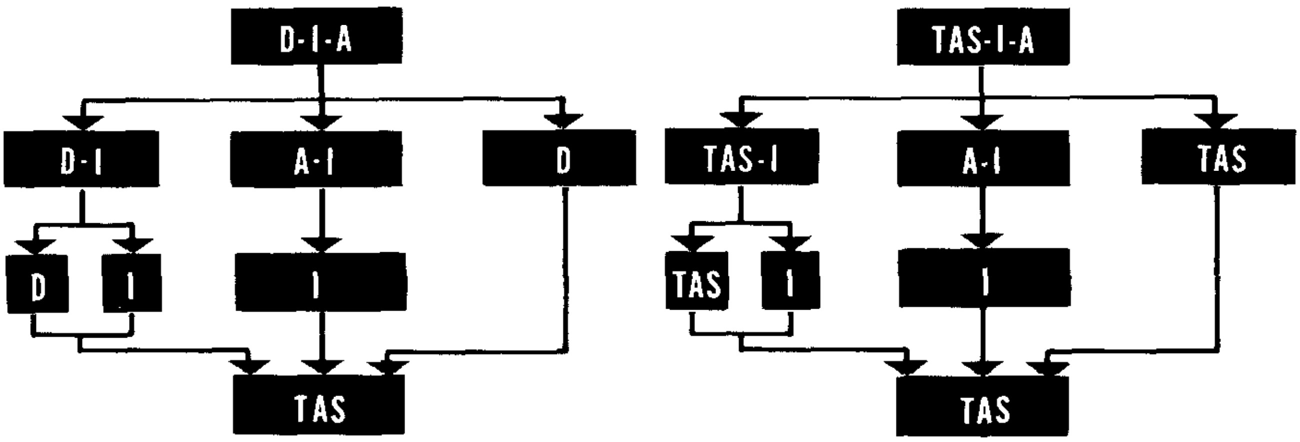
The letters IFF are visible on the lamp when lighted.

BOMBING NAVIGATION SYSTEM (MARK IIB).

The Mark IIB bombing navigation (bomb nav) system is an aided-inertial digital system consisting of the inertial navigation set (INS), the control and display set (CDS) and the digital computer complex (DCC). The system operates in conjunction with other weapon system avionics equipment to provide the following functions: Refer to figure 1-46.

- Platform Alignment—A capability is provided for alignment of the inertial platform either on the ground, or while in flight using reference data from other avionics equipment. In addition, a capability is provided for automatically calibrating the inertial components in the INS.
- Self-Contained Navigation — The capability is provided for autonomous inertial navigation using only the INS and the CDS or inertial navigation wherein the DCC utilizes inputs from the INS to provide navigation functions.
- Augmented Navigation—Utilizing reference inputs from the astrocompass, the doppler radar and/or the central air data computer, the system provides the capability for five different aided-inertial navigation modes. In the event of failure of any one or more of the systems which provide inputs to the system, the system regresses to the next navigation mode automatically in accordance with a mode hierarchy selection. (See figure 1-47.)
- Auxiliary Navigation—In the event of failure of the INS, the system utilizes reference inputs from the doppler radar and the central air data computer to provide dead-reckoning navigational functions.
- Supporting Navigation Functions—The system maintains a continuous knowledge of the following navigation-related parameters for display and/or transmission to the systems; present position latitude and longitude coordinates, roll and pitch attitude, groundspeed, groundtrack, true heading, magnetic

Navigation Sensor Selection Hierarchy



1. The point at which the hierarchy is entered is determined by the state of the nav mode select pushbuttons on the NDU. For example D-I mode is selected if the D and I pushbuttons are depressed.
2. D-TAS or A modes are not exclusively selectable on the nav mode select pushbuttons.
3. If no pushbuttons are depressed, or the A only is depressed, TAS-I-A is selected.
4. If a unit fails, the computer selects the next lower mode as shown by the hierarchy chart. For example, if D-I is selected and D fails, the nav mode regresses to I.
5. During inflight alignments, if the selected reference velocity is lost, the system does not select a backup reference velocity.

F0000000-F024A

Figure 1-47.

heading, magnetic variation, drift angle, wind speed, wind direction, altitude above sea level, star altitude error and heading difference, and time and distance to destination.

- Mission Data Storage—A capability is provided for storage of the latitude, longitude, and elevation of 109 data points (149 after T.O. 1F-111(B)A-651). These data points are assigned to two sequence tables; one table consists of 50 fixpoints (25 after T.O. 1F-111(B)A-651), the other 50 destination/targets (75 after T.O. 1F-111(B)A-651). Each destination or target may have two offset aimpoints associated with it. In addition, the capability is provided for the storage of the latitude and longitude of ten fixpoints or targets of opportunity whose location is determined during a mission through the use of system sensors. A capability is also provided to store the ballistic constants of 17 different weapon types. Star data for 57 stars are stored for use in astro modes.
- Data Entry—A capability is provided for either automatic or manual entry of mission-related data into the computer complex; automatic data entry is accomplished through use of a flight-line tape reader.
- Mission Sequencing—Automatic sequence of destination/targets (including offset aimpoints) and fixpoints can be established in the order in which they will be encountered during a mission; these sequence points are then automatically selected at the appropriate time during the flight for steering, fixtaking, weapon delivery, etc. A further capability is provided to interrupt the automatic sequence at any time or to divorce the system entirely from the automatic sequence.
- Navigation Steering—The system provides steering error signals to the autopilot and horizontal situation indicator (HSI) and bank steering commands to the attitude director indicator (ADI) and optical display sight (ODS). In certain system operating modes, pitch steering commands are also provided to the ADI and ODS. Six different navigation steering modes are provided, including a self contained airborne instrument low approach (AILA) mode for instrument landing on runways not equipped with ground-based letdown systems.
- Fixtaking—A capability is provided to effect present position corrections through the use of visual sighting techniques or with data provided by the attack radar or the astrocompass. Provisions are also made for determining and automatically storing the coordinates of fixpoints through the use of visual sighting techniques or the attack radar. In addition, the system operating in conjunction with the attack radar and the radar homing and warning system (RHAWS) provides a capability to determine and store the coordinates of ground-based radar emitters.
- Weapon Delivery—The system performs the computations and control functions required for air-to-ground weapon delivery against designated targets. The computations include automatic ballistics, steering error, time-to-go, weapon bay doors open signal, and weapon release point. A total of nine different modes is available, five synchronous radar modes and four visual modes. Special provisions are included to supply navigation data to the SRAM system.
- System Self-Test/Built-in-Test—Comprehensive self-test and built-in-test features are provided by the system. The self-test (continuous, non-interfering test) and built-in test (manually, cockpit initiated tests) capabilities are provided to detect failures and identify the faulty subsystem and LRU to permit the operator to evaluate the effect of the failure on mission performance.

INERTIAL NAVIGATION SET.

The inertial navigation set (INS) is a fully automatic, self-contained inertial navigator which contains the following major components:

1. Navigation Computer Unit (NCU)—The NCU, located in the left-hand, forward equipment bay, is a self-contained digital navigation computer providing basic navigation computations when supplied inputs of velocity and heading. The NCU also provides the control and self-test functions for the inertial reference unit.
2. Inertial Reference Unit (IRU)—The IRU is located in the forward equipment bay. It contains a four gimbal, all attitude inertial platform and its associated electronics. The IRU provides basic outputs of velocity, heading, and aircraft attitude.
3. Battery Unit (BU)—The BU, located in the left-hand forward equipment bay, provides power for periods up to five seconds, to the NCU and IRU during aircraft electrical system transients. The BU also contains overtemperature sensing circuitry for the NCU, IRU, and itself.

CONTROL AND DISPLAY SET.

The control and display set (CDS) consists of two units, the navigation display unit (NDU) located on the right main instrument panel, and the computer control unit (CCU) located on the right console. The control and display set provides the following functions:

- Control of primary electrical power to the avionics of the bomb nav system, doppler radar and astrocompass.
- Entering, changing, and recalling of digital computer data.
- Display of navigation, weapon delivery, and operational status data.
- Selection and control of functional and operational modes.
- Selection, display, and reset of built-in-test functions.
- Display of continuously monitored self-test results.

The CDS is capable of directly transmitting data to, or directly receiving data from, either general purpose digital computer of the DCC via the converter set (CS). The CDS also has the capability of directly transmitting data to, or directly receiving data from the inertial navigation set (INS). The data channels to or from the INS are independent of the converter set (CS). The NDU is capable of receiving serial digital data over any one of three data channels at any one time. Two of the channels transmit data from the CS (one channel being redundant) and the third channel transmits data from the INS and is monitored by the NDU only during autonomous INS operation. The CCU transmits serial digital data over two data channels. One channel transmits data to the CS and the other channel transmits data to the INS for use during INS autonomous operation.

DIGITAL COMPUTER COMPLEX.

The digital computer complex (DCC) is located in the forward electronics bay and is made up of the general navigation computer (GNC), the weapon delivery computer (WDC), and the converter set (CS). The GNC is programmed to handle all navigation functions, and has a weapon delivery backup capability. The WDC performs weapon delivery control, provides system self-test, and backup for navigation modes. The CS acts as a buffering logic and signal conversion device between the computers and other aircraft subsystems.

CONTROLS AND INDICATORS.

Function Select Knob.

The seven position function select knob (37, figure 1-48), located on the computer control unit (CCU) controls power turn-on and system operating modes. The knob is pull-to-turn in the OFF and GND ALIGN positions. The knob markings and functions are as follows:

1. OFF—Inhibits power application to the astrocompass, doppler, and bomb nav system.
2. GND ALIGN—Enables any of the four ground alignment modes. Applies power to the bomb nav system, including the INS, provided the ground align knob is in any position other than INS OFF. Enables power to be applied to the astrocompass and the doppler radar provided the ASTRO and DOPP pushbuttons are depressed.
3. NAV—Enables all navigation modes and inflight alignment modes.
4. BOMB RADAR—Enables weapon delivery modes in which the attack radar is utilized to detect a target or its offset aimpoints. In this mode steering is provided to direct the aircraft to the weapon release point.
5. BOMB VISUAL—Enables weapon delivery modes in which visual sighting techniques are employed to detect a target.
6. SRAM—Same as NAV position except that all doppler outputs are isolated from the DCC if the INS is selected and operating.
7. MANUAL—Interrupts automatic sequencing and permits manual selection for navigation and bombing.

Fix Mode Selector Knob.

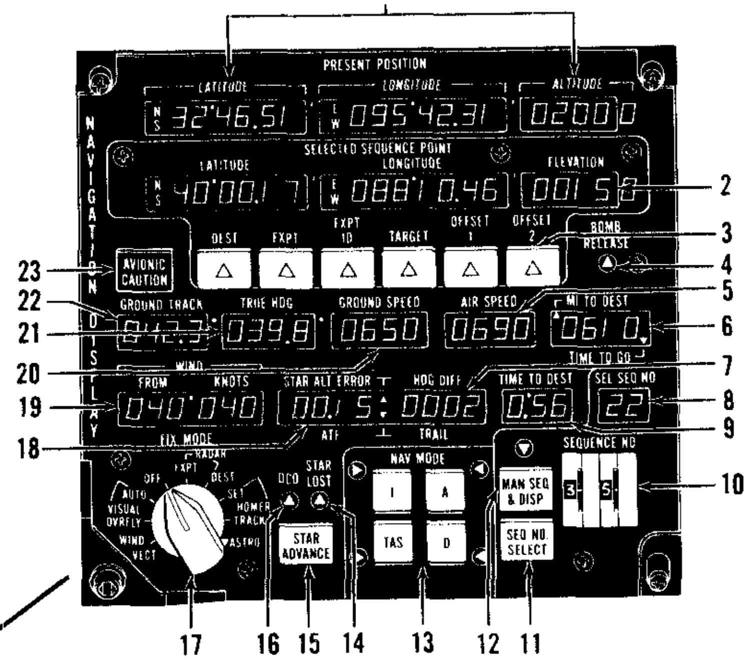
The nine position fix mode selector knob (17, figure 1-48), located on the navigation display unit (NDU) is used to select the desired fixtaking mode for either present position correction or storage of the coordinates of fixpoints. The knob markings and functions are as follows:

1. OFF—Terminates and disables all fixtaking modes.
2. WIND VECT—Enables the wind vector fix mode. This mode is a back-up mode and is used to refine stored wind data for use during the true airspeed navigation mode.
3. VISUAL OVERFLY—Enables the visual overfly present position correction or fixpoint ID fixtaking mode. In this mode, the aircraft is flown over a point and at the instant of overfly, the enter visual fix (EVF) button on the throttle is depressed causing the present position counters to be up dated (100 percent) to the coordinates of the selected point (present position correction) or causing the present position counter coordinates to be stored in the fixpoint ID table.
4. VISUAL AUTO—Enables the visual automatic present position correction or fixpoint ID fixtaking mode. In this mode, the ODS is used to visually acquire the selected point. When the pipper is coincident with the point and the EVF button is depressed, the present position counters are updated (AKURON) to the coordinates of the selected point (present position correction) or the present position coordinates are used to determine the coordinates of the point under the pipper (fixpoint ID).
5. RADAR FXPT—In this mode, the attack radar is used to acquire the fixpoint. If the intersection of the radar cursors does not lie over the fixpoint, the tracking control handle is used to position the cursors on the point. The computer maintains knowledge of the tracking control handle movements to refine knowledge of present position coordinates.
6. RADAR DEST—This mode is identical to the radar fixpoint mode except that destination coordinates are applicable rather than fixpoint coordinates.
7. HOMER SET—The HOMER SET position on the fix mode selector knob causes a circular cursor to appear on the RHAW scope. The tracking control handle is used to position this cursor over the radar station return (the attack radar cursors are positioned over the same point). The radar station lo-

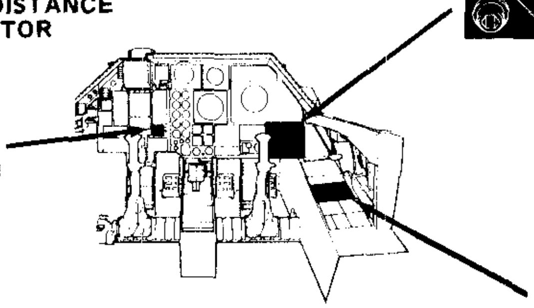
Bomb Nav Control Panels (Typical)

1. Present Position Displays.
2. Selected Sequence Point Displays.
3. Selected Sequence Point Pushbuttons (6).
4. Bomb Release Lamp.
5. Airspeed Display.
6. Miles To Destination/Time To Go Display.
7. Heading Difference/Trail Display.
8. Selected Sequence Number Display.
9. Time To Destination Display.
10. Sequence Number Set Wheels.
11. Sequence Number Select Pushbutton.
12. Manual Sequence and Display Pushbutton.
13. Nav Mode Select Pushbuttons.
14. Star Lost Lamp.
15. Star Advance Pushbutton.
16. Doppler Cutoff Lamp.
17. Fix Mode Selector Knob.
18. Star Altitude Error/Actual Time of Fall Display.
19. Wind Display.
20. Ground Speed Display.
21. True Heading Display.
22. Ground Track Display.
23. Avionic Caution Lamp.

NAVIGATION DISPLAY UNIT PANEL



BOMB NAV DISTANCE TIME INDICATOR



24. Altitude Calibration Pushbutton.
25. Altitude Calibration Ready Lamp.
26. Data Storage Display.
27. Data Number Display.
28. Address Selector Knob (No 1)
29. Data Switch.
30. Address Selector Knob (No. 2).
31. Test Indicator Lamps.
32. Test Switch.
33. General Navigation Computer Power Switch.
34. Weapons Delivery Computer Power Switch.
35. Test Selector Knob
36. Indicator Lighting Control Knob.
37. Function Select Knob
38. Manual Ballistics Pushbutton.
39. Astrocompass Pushbutton.
40. Doppler Radar Pushbutton.
41. INS Align Indicator Lamp.
42. INS Reset Button.
43. INS Heat Indicator Lamp.
44. INS Ground Align Knob.
45. Date Entry Pushbuttons.

COMPUTER CONTROL UNIT PANEL

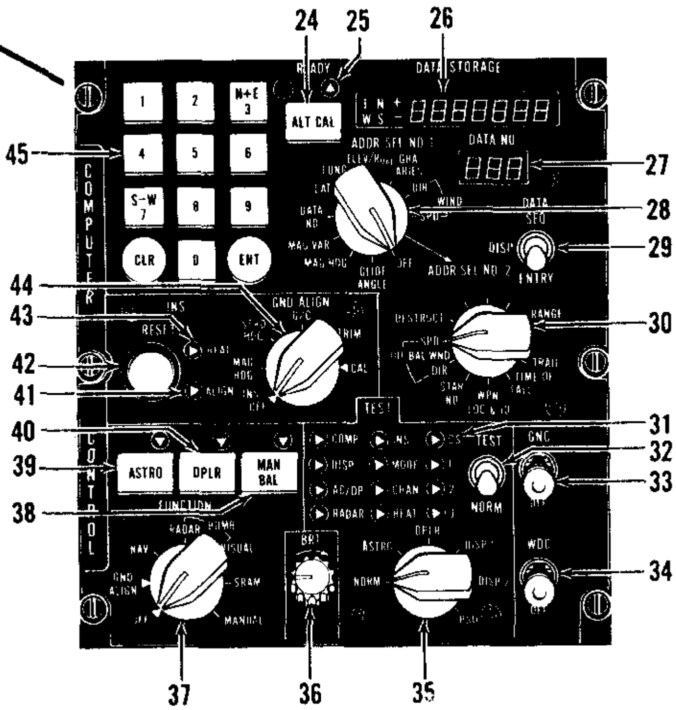


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Figure 1-48.

cation is computed from its azimuth and elevation angles and height above terrain. Positioning the fix mode selector knob to OFF will store the coordinates of the cursor position.

8. HOMER TRACK—The cursors are initially positioned using the HOMER SET position. When the fix mode selector knob is rotated to the HOMER TRACK position, the circular cursor is replaced by a bearing line cursor on the RHAW scope. Further tracking control handle corrections along this bearing line will refine the locations of the station in range. Positioning the fix mode selector knob to OFF will store the coordinates of the cursor position.
9. ASTRO—Enables the astrocompass, two-star present position correction fixtaking mode. Assuming the astrocompass is already locked on and tracking a star, engagement of this mode causes the astrocompass to break lock and search for the next star within the field of view in the computer table. When track on the second star is achieved, the DCC utilizes the azimuth and elevation data from both stars to refine present position. After processing these data, this procedure is continuously repeated using subsequent stars. The knob must be pulled out to turn to or from the ASTRO position.

INS Ground Align Knob.

The six position INS ground align knob (44, figure 1-48), located on the CCU is labeled GND ALIGN. The knob is used to select the desired INS alignment or calibration mode and to apply power to the INS. The knob is inactive unless the function select knob is in a position other than OFF. The knob must be pulled out to turn to or from the INS OFF, TRIM and CAL positions. The normal method of ground alignment is by gyrocompassing. This method requires adequate time allowances for gyro warm-up and azimuth alignment by sensing of earth rate. In this mode, the inertial platform initially is caged to zero roll and pitch for approximately 30 seconds. At the completion of the cage phase, the platform enters a partial alignment phase. The align lamp will come on steady 90 seconds after power has been applied to the INS. When coarse level alignment is achieved, the I advisory lamp will come on and the primary attitude caution lamp will go out. At this time the navigation function can be entered with degraded accuracy. When it is determined that the platform level is within prescribed limits, the partial align phase is completed and a primary attitude good signal is issued. The issuance of this signal will cause the primary attitude caution lamp to go out if primary reference is selected, and will cause the inertial navigation (I) mode indicator lamp to come on. The heading caution lamp will go out provided the DCC heading good signal has been issued. This indicates to the operator that the INS is capable of functioning as an attitude reference and can be used to supply roll and pitch to the flight reference system at this time. The final alignment phase is signified by the flashing of the align lamp. Alternate methods of ground alignment of the inertial system are (1) alignment to stored heading, (2) alignment of stored magnetic variation, and (3) alignment by two-axis trim procedures. The alignment to stored heading is a rapid alignment of the bomb nav system utilizing information stored in the INS computer from previous operation. This mode is accurate only when a gyrocompass alignment and less than 30 minutes of navigation were accomplished prior to system turn on, and the aircraft has not been moved since previous system turn off. Alignment to stored magnetic variation is a rapid alignment of the bomb nav system utilizing information stored in the INS computer from previous operation. This mode assumes that the system was gyrocompass aligned, was in the navigation mode for less than 30 minutes, present position has not changed significantly (600 feet), that magnetic variation has remained essentially constant, and that aircraft heading has not changed by more than 2.5 degrees. These requirements allow the aircraft to be moved provided the aircraft is returned to approximately to same heading and magnetic variation has not been changed. Two axis trim provides the capability for trimming both the north and east uncompensated gyro drift rates during a ground alignment mode. This alignment consists of two gyrocompass alignments during which the platform azimuth is slewed 90 degrees under DCC control. An opportunity to enter the navigation mode with gyrocompass accuracy exists during the 20 seconds of flashing align lamp indication after completion of the first gyrocompass. If the navigation mode is not commanded during this 20 second interval the DCC will cause the align lamp to cease flashing and will slew the stable element 90 degrees. Subsequent to this slewing a second gyrocompass alignment is initiated. This alignment is complete when the align lamp comes on and starts flashing. In-flight alignment is accomplished by rotating the INS ground align knob from OFF to any position except TRIM or CAL when the function select knob is in any position except OFF or GND ALIGN.

Note

> If the INS has been ground aligned and is operating in-flight and it is desired to initiate an in-flight alignment, the INS ground align knob must be positioned to OFF and back on as noted above.

When an in-flight alignment is initialized by the DCC, the align lamp will come on steady and the primary attitude and heading caution lamps will be on. When the platform has been leveled to within prescribed

limits, the primary attitude and heading (provided the DCC heading good signal is present) caution lamps will go out and the inertial navigation mode lamp will light. Completion of in-flight alignment will be indicated when the align lamp goes out. In-flight alignment requires external position and/or velocity reference data. Consequently, the doppler and astro systems should be energized as desired, and the desired navigation mode pushbuttons must be selected. As soon as possible a position fix should be accomplished. If a navigation mode pushbutton is not selected a TAS-I in-flight alignment is commanded. If the inertial navigation mode pushbutton only is selected, numerous position fixes will be required to accomplish the alignment. The knob markings and functions are as follows:

1. INS OFF—Removes power from the INS.
2. MAG HDG—Initiates the stored magnetic variation rapid platform alignment mode.

Note

For an accurate stored magnetic variation alignment the INS must have undergone an accurate gyrocompass alignment and the aircraft, if moved, must be returned to within 2.5 degrees of the original heading and magnetic variation must have remained essentially unchanged.

3. STRD HDG—Initiates the stored heading, rapid platform alignment mode.

Note

For an accurate stored heading alignment the INS must have undergone an accurate gyrocompass alignment and the aircraft must not have been moved since the system was turned off.

4. G/C—Initiates the normal, ground gyrocompass alignment mode.
5. TRIM—Initiates the two-axis trim calibration mode. In this mode, the north and east uncompensated platform drift rates are automatically trimmed. The mode may be selected before, during or after any of the ground alignment modes. The first phase of this mode causes trimming of the north uncompensated drift rate; at the completion of this phase the align lamp commences flashing. If at the end of 20 seconds a navigate mode is not selected, the platform is automatically rotated 90 degrees and the east uncompensated drift rate is trimmed; the align lamp is on steady during this phase. Two-axis trim complete is signified by the flashing of the align lamp upon completion of the second phase.

Note

Erroneous primary heading information will result if the function select knob is placed in NAV while the platform is being slewed to a new heading.

6. CAL—This is a maintenance function only and requires that a special calibration program be loaded into the computer complex memory.

Address Selector Knobs.

The two twelve position address selector knobs (28, and 30, figure 1-48), located on the CCU are labeled ADDR SEL NO. 1 and ADDR SEL NO. 2. The knobs are used to select automatic addressing for data words being entered into or recalled from the computers. Address selector knob No. 1 is marked: GLIDE ANGLE, MAG HDG, MAG VAR, DATA NO, LAT, LONG, ELEV (aircraft 3 ▶ 52) or ELEV/R MAP (aircraft 53 ▶) GHA ARIES, WIND DIR, WIND SPD, (transfer), and OFF. When the knob is in the (transfer) position, the control of automatic addressing is transferred to address selector knob No. 2. When address selector knob No. 1 is in the OFF position all address functions are disconnected. Address selector knob No. 2 is labeled DESTRUCT, RANGE, TRAIL, TIME OF FALL, WPN LOC & ID, STAR NO., DIF BAL WND DIR and DIF BAL WND SPD. On the address selector No. 1 knob, the MAG HDG position is for display only; on the address selector No. 2 knob, the STAR NO. position is for display only. The display of these quantities is achieved by placing the appropriate selector knob in the appropriate position and placing the data entry mode selector switch to the DISP position; the parameter value is then displayed in the data storage counter. The operator has the capability to manually enter all other parameters using the address selector knobs.

Test Selector Knob.

The five position test selector knob (35, figure 1-48), located on the CCU is included in the test portion of the system. The knob is used to select built-in test functions. The knob markings and functions are as follows:

1. NORM—Continuously monitored self-test modes.
2. ASTRO—Initiates the astrocompass built-in self-test mode.
3. DOPPLER—Selects the doppler radar built-in self-test mode.
4. DISP 1—Applies power to all alpha and numerical tests and display lamp segments to verify their operation.
5. DISP 2—Cycles all test and display lamps through all patterns to verify lamps and logic.

Note

The test switch must be in the TEST position to initiate ASTRO, DOPPLER, DISP 1 and DISP 2 tests

Indicator Lighting Control Knob.

The indicator lighting control knob (36, figure 1-48), located on the CCU is labeled BRT. Turning the knob clockwise increases brightness on both NDU and CCU.

CAUTION

Use only the degree of brightness required to see the lights. Maximum brightness (full CW) greatly decreases the life of the elements and requires replacement of entire NDU and CCU panels

Nav Mode Select Pushbuttons.

The four nav mode select pushbuttons (13, figure 1-48), located on the navigation display unit (NDU) are labeled NAV MODE. The buttons are push-on, push-off type. An indicator lamp located by each button will light to provide an indication of the navigation mode currently in use. The buttons are marked and function as follows:

I — Selects the inertial mode of navigation and must be used for inflight alignment.

A — Selects the astrocompass mode of navigation.

D — Selects the doppler radar mode of navigation. When the pushbutton is activated, the doppler radar is placed in the operate (radiating) mode. The doppler radar pushbutton must be activated prior to selection of the "D" doppler mode.

Note

When the doppler operate lamp lights the following conditions are indicated:

- D — doppler pushbutton has been selected, ground speed is greater than 100 KIAS, drift is less than 25 degrees and the system is reliable.
- Doppler and inertial, if selected, are in reasonable agreements.

TAS — Selects the central air data computer for CADC augmented automatic navigation, or air data dead reckoning navigation modes. The indicator lamp will light if the DCC determines that the CADC is operating and is in use.

Data Entry Pushbuttons.

The twelve data entry pushbuttons (45, figure 1-48), are located on the CCU. The pushbuttons are momentary-contact, push-on, release-off switches which are used to manually enter data into, or recall data from the DCC or the INS. Data entered by the keyboard is displayed on the data storage or data no. counters. Each push-button contains an integral lamp to light the switch lens engraving. Pushbuttons 0 thru 9 are for digit inputs. Pushbuttons 3 and 7 are also used to enter + or − signs or latitude, longitude coordinate symbols (N, E, W, S). The button marked CLR (clear) blanks the data storage counter. The ENT key (enter) causes information to be transferred from the data storage counter to the computers. The following data can be automatically entered by use of a flight line tape reader:

- Star data table
- Wind profile table
- Weapon location and ID table
- Blast radii table
- Fixpoint sequence table
- Destination/target sequence table
- Data points table
- Glide angle
- Weapon range, trail, and time of fall
- Differential ballistic wind
- Magnetic variation

Manual data entry of the following mission parameters can be accomplished when desired:

- Data points
- Greenwich hour angle
- Wind direction and speed
- Glide angle (for AILA)
- Magnetic variation
- Differential ballistic wind
- Weapon location and identification
- Weapon range
- Weapon trail
- Weapon time of fall

Altitude Calibration Pushbutton.

The altitude calibration pushbutton (24, figure 1-48), is located on the CCU. The pushbutton is marked ALT CAL and is a push-on, push-off switch which initiates the pressure altitude calibration mode when pressed into an active state. Prior to T.O. 1F-111(B)A-651, a green lamp marked READY, mounted adjacent to the pushbutton, will light when a signal is received from the CS, indicating that a pressure altitude calibration can be made. The lamp will go out when the ALT CAL pushbutton is pressed into an inactive state, or when a reset signal is received from the CS. After T.O. 1F-111(B)A-651, the green lamp will light when the ALT CAL pushbutton is pressed into an active state, and will go out when the pushbutton is pressed into an inactive state.

Astro Compass Pushbutton.

The astro pushbutton (39, figure 1-48), is located on the CCU. The pushbutton is marked ASTRO and is a push-on, push-off switch which is used to apply power to the astrocompass. An indicator lamp mounted adjacent to the pushbutton will light when the astro pushbutton is in an active mode.

Doppler Radar Pushbutton.

The doppler pushbutton (40, figure 1-48), is located on the CCU. The pushbutton is marked DPLR and is a push-on, push-off switch which is used to put the doppler radar in standby. An indicator lamp mounted adjacent to the pushbutton will light when the doppler pushbutton is in an active mode.

Manual Ballistics Pushbutton.

The manual ballistics pushbutton (38, figure 1-48), is located on the CCU. The pushbutton is a push on push off switch marked MAN BAL. When activated the computer will use the hand entered values of trail/ range and time-of-fall for weapons delivery. An indicator lamp mounted adjacent to the pushbutton will light when the MAN BAL button is in an active mode.

Star Advance Pushbutton.

The star advance pushbutton (15, figure 1-48), located on the NDU, is marked STAR ADVANCE. The button is a momentary-on switch and when activated, provides a star advance signal to the general navigation computer (GNC) to select the next star within the astrocompass field-of-view. A lamp labeled STAR LOST located by the pushbutton will light to provide an indication that the star selected for reference is not being tracked.

Sequence Number Select Pushbutton.

The sequence number select pushbutton (11, figure 1-48), located on the NDU is marked SEQ NO. SELECT. The pushbutton enables the operator to make changes in the route point sequencing.

Manual Sequence and Display Pushbutton.

The manual sequence and display pushbutton (12, figure 1-48), located on the NDU is marked MAN SEQ & DISP. The pushbutton is a push-on, push-off type. A lamp adjacent to the pushbutton will light when the button is depressed. Depressing the button enables the display of any set of route point coordinates, selected by the sequence number set-wheels, and interrupts automatic sequencing.

Enter Visual Fix Pushbutton.

The enter visual fix pushbutton (1, figure 1-5), located on the left throttle of the left set is marked EVF. The pushbutton when depressed is used for visual fixtaking and visual fixpoint ID.

Selected Sequence Point Pushbuttons.

The six selected sequence point pushbuttons (3, figure 1-48), are located on the NDU. The DEST, FXPT, TARGET, OFFSET 1 and OFFSET 2 pushbuttons define which type of sequence point coordinates are to be displayed, and also during manual data entry define for the DCC what type of sequence point coordinates are being entered. The FXPT ID pushbutton is used in conjunction with the fix mode selector knob to enable the fixpoint ID mode. In the fixpoint ID mode the radar cursors can be driven to overlay the point of interest whose coordinates are unknown. The computer determines the coordinates of the unknown point from knowledge of the starting point of the cursors and the tracking handle corrections. The coordinates of the instantaneous position of the cursors are displayed on the selected sequence point displays in this mode and the selected sequence number display indicates the current fixpoint ID sequence number. When the operator terminates the mode, the coordinates of the cursors are stored in the fixpoint ID table in the computer. The coordinates of the fixpoint ID point can be subsequently recalled by depressing the fixpoint ID pushbutton, selecting the appropriate fixpoint ID sequence number, and depressing the manual sequence and display pushbutton. Only one button can be depressed at a time.

Sequence Number Set Wheels.

The two sequence number set wheels (10, figure 1-48), located on the NDU are labeled SEQUENCE NO. The setwheels are marked 0 thru 9. Together they generate a four-bit code to establish the automatic route point sequence, select stored route point coordinates for display, and advance or retard the route point sequence.

INS Reset Button.

The INS reset button (42, figure 1-48), located on the CCU is labeled RESET. When depressed, the button transmits a signal to the INS, commanding it to replace present position coordinates with those previously entered via the computer control unit panel keyboard pushbuttons. The reset button is operable only if the function select knob is in the GND ALIGN position, except during autonomous nav modes.

Data Switch.

The three position data switch (29, figure 1-48), located on the CCU is labeled DATA. The SEQ position is selected for entry of data pertaining to mission sequence. The DISP position is selected for recall and display of information for specific memory locations. The ENTRY position is used to enter data associated or not associated with a data number.

General Navigation Computer Power Switch.

The two position general navigation computer power switch (33, figure 1-48), located on the CCU is marked GNC and OFF. The switch is lever locked in the GNC position and supplies electrical power to the general navigation computer.

Weapon Delivery Computer Power Switch.

The two position weapon delivery computer power switch (34, figure 1-48), located on the CCU, is marked WDC and OFF. The switch is lever locked in the WDC position and supplies electrical power to the weapon delivery computer.

Note

> In the event of a failure of one computer and the operator desires to attempt to regain the two computer operation, it is necessary to manually switch both computers off and back to on. The computers must be turned on within 4 seconds of each other in this procedure. If only one computer and the INS are powered up simultaneously, the computer will halt.

Test Switch.

The two position test switch (32, figure 1-48), located on the CCU, is marked TEST and NORM. The TEST position enables a particular built-in-test function to be performed. The NORM position enables continuous monitoring and reporting self-test routines.

Avionic Caution Lamp.

The avionic caution lamp (23, figure 1-48), located on the NDU is labeled AVIONIC CAUTION. The avionic caution lamp will light in conjunction with a fault legend display on the CCU. The avionic caution lamp and fault legend will remain lighted until the fault is acknowledged by the operator. Acknowledgement is accomplished by depressing the avionic caution lamp once after which the avionic caution lamp and fault legend will go out and remain out if no other fault exists. If another fault exists, the fault legend for that fault and the avionic caution lamp will light until the new fault is acknowledged by the operator. Once acknowledged, the fault legend or avionic caution lamp will not light again due to reoccurrence of the same fault. Reoccurrence of faults will be reported only after a recall has been performed. Recall is accomplished when the operator depresses the avionic caution lamp when no fault legends nor the avionic caution lamp is lighted. This action clears any record of previous faults which have been reported. If no faults are reported at this time the avionic caution lamp and fault legends remain out until a fault occurs. If a fault is reported at this time or if any fault occurs thereafter, the avionic caution lamp and fault legend will light until the fault is acknowledged.

Test Indicator Lamps.

The 12 test indicator lamps (31, figure 1-48), located on the CCU are labeled TEST. The display is used to indicate the results of operator-initiated built-in tests, and of continuously-monitored self-tests. As many as three lamps associated with the test message may light while a test is in progress, and will go out if the test is passed. If the test is failed, the avionics caution lamp will light and the TEST display(s) will remain lighted on that test which failed. The test failure indications may be cleared by depressing the avionics caution lamp. The TEST displays are marked as follows:

COMP—Computer complex.

INS—Inertial navigation set.

CS—Converter set.

AC/DP—Astrocompass/doppler radar.

1, 2, 3—Used to designate combinations of failures. For example, COMP 1 indicates a GNC failure, CS2 indicates that area 2 of the CS has failed, INS 3 indicates that the INS battery unit has failed, etc.

MODE—Incompatible mode; crew selection or failure of a subsystem indicates an invalid mode state.

CHAN—Serial digital communications channel failure.

HEAT—INS or DCC overtemperature.

DISP—Control and display set.

RADAR—Doppler or attack radar.

Note

> Five different operations or sets of conditions which can cause an AC/DP CHAN test legend and avionic caution lamp are:
>
> 1. The aircraft makes heading changes exceeding astrocompass maximum yaw rates while the astrocompass is in the search mode (i.e., turning during taxi maneuvers).
> 2. The aircraft makes attitude changes exceeding 24 degrees up, 16 degrees down in pitch or 20 degrees in roll while the astrocompass is in slew mode.
> 3. Star tracking is attempted with marginal sky conditions.
> 4. The attitude reference is switched from the IRU to the AFRS.
> 5. GHA of Aries is updated while the astrocompass is not tracking a star.
>
> Except for item 4 the AC/DP CHAN test legend will clear by depressing the star advance and then the avionic caution lamp pushbuttons. Item 4 requires cycling of astro power and then depressing the pushbutton. In each case the star altitude error and heading difference displays will blank until the fault is cleared.

INS Align Indicator Lamp.

The INS align indicator lamp (41, figure 1-48), located on the CCU is marked ALIGN. The lamp will come on when a signal is received from the INS, indicating that the platform is aligning and will flash when the platform is fully aligned during ground alignment, or go out during inflight alignment.

INS Heat Indicator Lamp.

The INS heat indicator lamp (43, figure 1-48), located on the CCU is marked HEAT. The lamp will light when a signal is received from the INS, indicating that the IRU components have not reached operating temperature.

Bomb Release Lamps.

Two bomb release lamps, one on the upper warning and caution panel (figure 1-29) and the other on the NDU (4, figure 1-48), are labeled BOMB RELEASE. The bomb release lamp on the upper warning and caution panel will light when a bomb release signal is received from the SMS. The bomb release lamp on the NDU will light for 3 seconds when a bomb release signal is received from the CS.

WARNING

- Do not operate any of the bombing system controls when a release signal is present as indicated by the bomb release lamps. Operation of the master switch, station select switches, monitor and release knob, delivery mode knob, or selector mode knob during presence of a release signal may result in inadvertent store or bomb rack release.
- If the bomb release lamp remains on for an indefinite period of time (approximately 5 seconds or more) place the delivery mode knob OFF, selector mode knob OFF, and master switch OFF, in that sequence, perform "Abort Mission Procedures," Section IV, and do not attempt any practice bombing activity. When carrying non-nuclear weapons, fly over a suitable drop area before performing the above procedures as release will probably occur.

Primary Attitude Caution Lamp.

The primary attitude caution lamp, located on the main caution lamp panel (figure 1-29), will light when the attitude good signal from the INS is invalid or auxiliary reference is selected. When either of these situations occurs the primary heading lamp will light and the source of attitude and heading signals will be switched to the AFRS. The letters PRI ATTITUDE are visible on the lamp when lighted.

Primary Heading Caution Lamp.

The primary heading caution lamp, located on the main caution lamp panel (figure 1-29), will light when:

(1) the primary attitude signal from the INS is invalid or;

(2) the auxiliary reference is selected, or

(3) the primary heading is invalid.

When situations (1) and (2) occur the source of the primary attitude and heading signals will be switched to the AFRS. In situation (3), primary attitude only is provided to the flight instruments. The letters PRI HDG will be visible on the lamp when lighted.

WARNING

- If primary reference is selected and primary attitude is valid during INS autonomous operation the primary heading caution lamp will not light nor will correct heading be displayed on the pilot's flight instruments unless both computer (GNC and WDC) power switches are turned off.
- Auxiliary reference should be selected immediately when DCC fault causes INS autonomous operation. Auxiliary reference should be maintained until flight conditions permit verification of bomb nav system attitude and heading information to the flight instruments.

Present Position Displays.

The present position displays (1, figure 1-48), located on the NDU are labeled PRESENT POSITION. The displays are marked and provide the following indications.

1. LATITUDE—Display consists of one alpha numeric lamp followed by six numeric lamps. It displays latitude in degrees and minutes, to the nearest 0.01 of a minute.
2. LONGITUDE—Display consists of one alpha-numeric lamp followed by seven numeric lamps. It displays longitude in degrees and minutes, to the nearest 0.01 of a minute.
3. ALTITUDE—Display consists of four numeric lamps with a zero (0) engraved after the last lamp. It displays aircraft mean sea level pressure altitude in feet to the nearest 10 feet. For altitudes below sea level, the left counter displays a minus (—) sign.

Note

All latitude and longitude readouts can be in error by 0.01 of a minute of arc; for example N30 degrees 00.00 minutes may appear as N29 degrees 59.99 minutes.

Selected Sequence Point Displays.

The three selected sequence point displays (2, figure 1-48), located on the NDU are labeled SELECTED SEQUENCE POINT. The displays are marked and provide the following indications:

1. LATITUDE—Display consists of one alpha-numeric lamp followed by six numeric lamps. It displays latitude of the sequence point in use as determined by the selected sequence point pushbuttons and the automatic route point sequence. The display reads in degrees and minutes, to the nearest 0.01 of a minute.
2. LONGITUDE—Display consists of one alpha-numeric display lamp followed by seven numeric lamps. It displays longitude of the sequence point in use as determined by the selected sequence point pushbuttons and the automatic route point sequence. The display reads in degrees and minutes, to the nearest 0.01 of a minute.
3. ELEVATION—Display consists of four numeric lamps, with a zero (0) engraved after the last lamp. It displays mean sea level elevation of the sequence point in use as selected by the selected sequence point pushbuttons and the automatic route point sequence. It displays the elevation in feet to the nearest 10 feet. For altitudes below sea level, the left display displays a minus (—) sign.

Ground Track Display.

The ground track display (22, figure 1-48), located on the NDU is marked GROUND TRACK and displays aircraft true ground track, in degrees to the nearest 0.1 degree.

True Heading Display.

The true heading display (21, figure 1-48), located on the NDU, is marked TRUE HDG, and displays aircraft true heading, in degrees, to the nearest 0.1 degree.

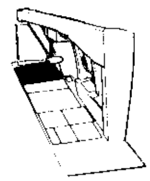
Ground Speed Display.

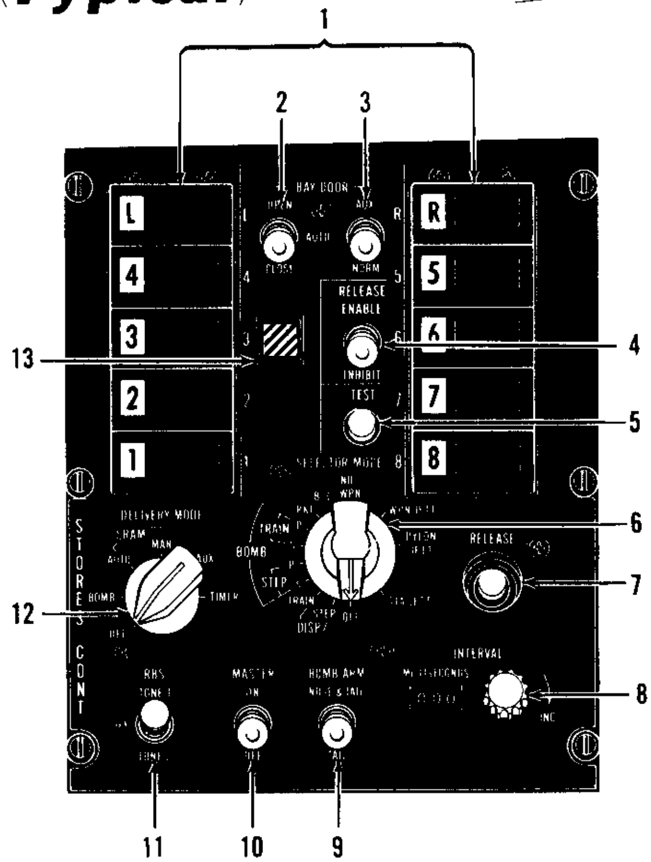
The ground speed display (20, figure 1-48), located on the NDU is marked GROUND SPEED and displays aircraft ground speed, in knots to the nearest knot.

Airspeed Display.

The airspeed display (5, figure 1-48), located on the NDU, is marked AIR SPEED, and displays aircraft true air speed in knots to the nearest knot.

Stores Control Panel (Typical)





1. Stores Station Selector Switches (10).
2. Weapons Bay Door Control Switch.
3. Weapons Bay Door Auxiliary Switch.
★ 4. Release Enable Switch.
5. Stores Present Test Button.
6. Weapons Mode Selector Knob.
7. Weapon Release Button.
8. Intervalometer Set Knob.
9. Bomb Arming Selector Switch.
10. Master Power Switch.
11. RBS Tone Switch.
12. Delivery Mode Selector Knob.
13. Weapons Bay Door Position Indicator.

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Figure 1-49.

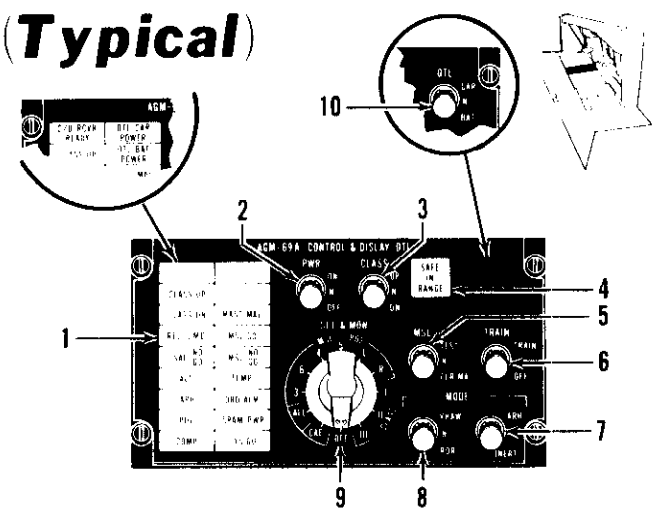
Miles-to-Destination/Time-to-Go Display.

The miles-to-destination/time-to-go display (6, figure 1-48), located on the NDU is marked MI TO DEST/TIME TO GO. A lamp is mounted adjacent to each function, and when lighted, indicates that parameter is being displayed. In the NAV mode, the display displays distance to destination in nautical miles. In the RADAR BOMB modes, it displays time-to-go to weapon release in seconds. In VISUAL BOMB, the display will be blanked until either weapon release has been depressed, at which time it will display the time remaining until actual weapon release.

Wind Displays.

The two wind displays (19, figure 1-48), located on the NDU, are labeled WIND FROM/KNOTS and continuously display the computed value of wind direction and magnitude. The display marked FROM displays the direction from which the wind is blowing, in degrees. The display marked KNOTS displays the wind speed in knots.

SRAM Control Panel (Typical)



1. Status and Malfunction Indicator Lamps.
2. Power Switch.
3. Class Switch.
4. Safe-In-Range Indicator Lamp.
5. Missile Switch.
6. Train Switch.
7. Anti-Radiation Homer/Inertial Mode Switch.
8. RHAW/Radar Mode Switch.
9. Select and Monitor Control Knob.
10. OTL (Operational Test Launch) Switch.

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Figure 1-50.

Star Altitude Error/Actual Time of Fall Display.

The star altitude error/actual time of fall display (18, figure 1-48), located on the NDU is marked STAR ALT ERROR and ATF. A lamp is mounted adjacent to each function and when lighted indicates that parameter is being displayed. In the NAV mode, the display displays start altitude error, in arc-minutes. The alpha-numeric lamp displays either an A (Away) or T (toward). In the RADAR or VISUAL BOMB modes, it displays the actual time of fall in seconds.

Heading Difference/Trail Display.

The heading difference/trail display (7, figure 1-48), located on the NDU is marked HDG DIFF and TRAIL. An indicator lamp is mounted adjacent to each function, and when lighted indicates that parameter is being displayed. In the NAV mode, it displays the heading difference, in arc-minutes. The first alpha-numeric lamp reads either a plus (+) or minus (−). In the RADAR or VISUAL BOMB modes, it displays trail to the nearest 10 feet.

Time-to-Destination Display.

The time-to-destination display (9, figure 1-48), located on the NDU is marked TIME TO DESTINATION. The display consists of three numeric lamps and displays time to destination, in hours and minutes.

Selected Sequence Number Display.

The selected sequence number display (8, figure 1-48), located on the NDU is marked SEL SEQ NO. The display consists of two numeric lamps and displays the sequence point in use as determined by the selected sequence point pushbutton.

Data Storage Display.

The data storage display (26, figure 1-48), located on the CCU is marked DATA STORAGE. The display consists of one alpha-numeric lamp and seven numeric lamps to display data being entered into, or recalled from, the DCC or the INS. Alpha characters (N, S, E, W, +, or −) are displayed on the left lamp and decimal characters 0 thru 9 appear on the other lamps from right to left, character-by-character.

Data Number Display.

The data number display (27, figure 1-48), located on the CCU is marked DATA NO. The display consists of 3 numeric lamps to display the data number associated with the data being entered into or recalled from the DCC or the INS. A single data number for each set of coordinates (lat, long, elev) is entered from the keyboard switches prior to entering the data. The lamps are blanked when address selector No. 1 knob is rotated out of the LAT, LONG, or ELEV positions unless the data switch is in the DISP position.

Star Lost Lamp.

The star lost lamp (14, figure 1-48), located on the NDU, is a green indicator lamp which, when lighted, indicates that the astrocompass is not tracking a star.

Doppler Cutoff Lamp.

The doppler cutoff lamp (16, figure 1-48), located on the NDU is a green indicator lamp which, when lighted, indicates that the doppler is not tracking a good doppler return signal.

BOMB NAV SYSTEM OPERATION.

For bomb nav system operating procedures, refer to Section IV.

ARMAMENT SYSTEM.

The armament capability of the aircraft includes the delivery of conventional and nuclear weapons in various configurations. The stores are carried in the weapons bay and on eight wing pylons. Four of the wing pylons (3, 4, 5 and 6) pivot to remain streamlined with the longitudinal axis of the aircraft as the wing sweep is varied. The various equipment, controls and indications for the bombing or missile system, are covered in detail in the applicable delivery manual. T.O. 1F-111(B)A-25-1 for nuclear delivery, 1F-111(B)A-34-1-1 for conventional delivery and T.O. 1F-111(B)A-30-1 for missile delivery. Refer to Section V for a list of authorized stores.

EXTERNAL STORES GROUND JETTISON SWITCH.

The external stores ground jettison switch, located on the landing gear control panel (8, figure 1-16), has two positions marked ARM and OFF and is guarded in the OFF position. In the ARM position, the main landing gear safety (squat) switches are bypassed to allow emergency jettison of external stores during ground operation. In the OFF position external stores cannot be jettisoned while the weight of the aircraft is on the main landing gear.

BOMBING TIMER.

On aircraft 53 ▶ and those modified by T.O. 1F-111-(B)A-521, a bomb timer (figure 1-52) located on the auxiliary gage panel provides a backup for timed navigation and weapons release. The timer has the capability of time-to-go for 30 minutes and 59.9 seconds in increments of 0.1 seconds, and will generate a bomb release signal in the release mode of operation. On aircraft 23, 50 ▶ and those modified by T.O. 1F-111(B) A-608, the weapon release function of the bombing timer has been deactivated.

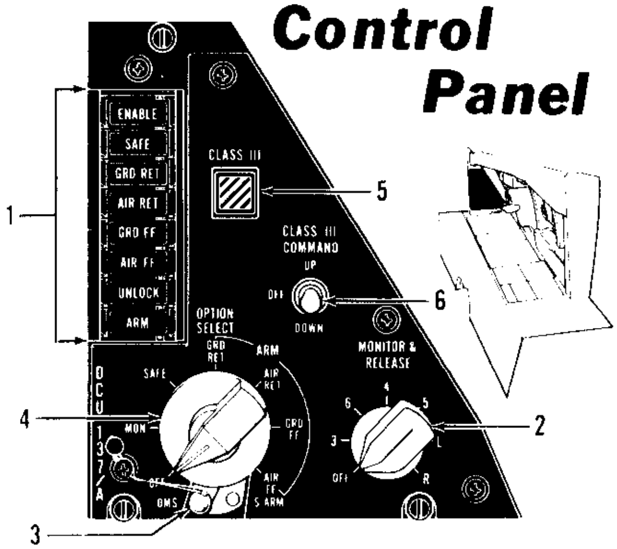
Power Selector Knob. The power selector knob, located on the bomb timer (1, figure 1-52), is labeled POWER. The knob has three positions marked OFF, ON and RELEASE. When the knob is rotated to the ON position power is turned on to the timer circuit. When the time cycle is started and drives to zero the time out lamp will come on. When the knob is rotated to RELEASE position, the time-out lamp will come on and a release signal is sent to the armament system when the timer drives to zero. This signal is present for a duration of two minutes unless removed by one of the following methods:

- Rotating the power selector knob out of the release position.
- Depressing the start/reset pushbutton.

Minute Command Counter. The minute command counter, located on the bomb timer (2, figure 1-52), is labeled MIN. The counter is driven by the minute command knob (8, figure 1-52), and has a range of 0 to 30 minutes in 1 minute increments. The counter is set to the value in minutes for desired countdown.

Seconds Command Counter. The seconds command counter, located on the bomb timer (4, figure 1-52), is labeled SEC. The counter is driven by the seconds command knob (7, figure 1-52), and has a range of 0

Nuclear Weapons Control Panel



1. Nuclear Weapons Monitor Lamps.
2. Nuclear Weapons Monitor and Release Knob.
3. Nuclear Weapons Arm Knob Lock Lever.
4. Nuclear Weapons Arm Knob.
5. Class III Status Indicator.
6. Class III Command Override Switch.

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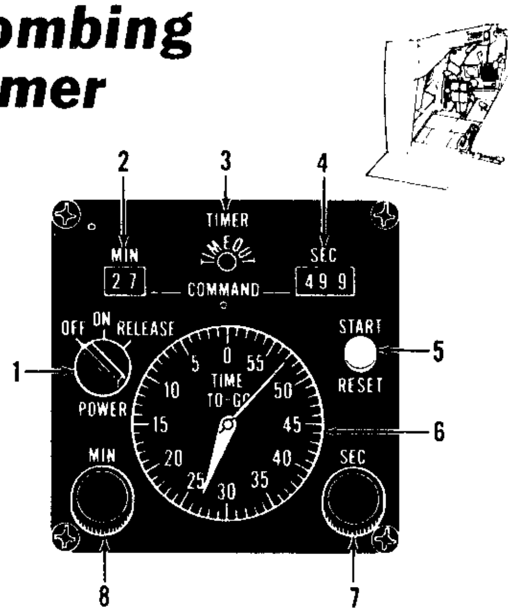
Figure 1-51.

Bombing Timer



1. Power Selector Knob.
2. Minute Command Counter.
3. Time Out Lamp.
4. Seconds Command Counter.
5. Start/Reset Pushbutton.
6. Timer-To-Go Clock.
7. Seconds Command Knob.
8. Minutes Command Knob.

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Figure 1-52.

to 59.9 seconds in 0.1 second increments. The counter is set to the value in seconds for desired countdown.

Start/Reset Pushbutton. The start/reset pushbutton, located on the bomb timer (5, figure 1-52), is labeled START RESET. When the pushbutton is depressed the time-to-go clock will drive to the settings on the minute and seconds command counters. When the pushbutton is depressed a second time the timing cycle will begin.

Time Out Lamp. The time out lamp, located on the bomb timer (3, figure 1-52), is labeled TIME OUT. The lamp will come on in all cases when the time-to-go display clock has driven to zero.

Time Out Indicator Lamp. The time out indicator lamp is located on the upper warning and caution lamp panel (15, figure 1-6). The lamp will light when the time-to-go clock has driven to zero. When lighted the letters TIME OUT are visible.

Time-To-Go Clock. The time-to-go clock, located on the bomb timer (6, figure 1-52), is labeled TIME-TO-GO. The clock is a graduated scale with a range of 0 to 60 in 1 digit increments. The large pointer will display minutes and the small hand will display seconds. The clock is set and started by the start/reset pushbutton.

WEAPONS BAY DOORS.

The weapons bay doors enclose the weapons bay area located between the nose and main landing gear. The doors are constructed in left and right clam shell halves which fold outward as they are opened. Normal and alternate systems are provided to operate the doors. The normal system utilizes hydraulic power from the utility hydraulic system to drive a hydraulic motor. The alternate system uses 115 volt ac power from the right main ac bus to power an electric motor. Either motor drives a gear reduction mechanism, which through a series of drive shafts interconnected to hinges on the inside of the weapons bay, to open and close the doors. Normal time to open or close is 2½ seconds. The alternate system takes approximately 30 seconds to open or close the doors. The weapons bay doors are controlled by the weapons bay door control switch which allows selection of manual opening or closing or automatic operation on signals from the bomb nav system. Selection of the alternate system for operating the doors is provided by the weapons bay door auxiliary control switch. When the alternate system is utilized, automatic operation of the doors should not be used.

CAUTION

To prevent damage to the door actuator motors during alternate operation there must be a 10-second interval between opening and closing the doors and no more than 3 complete door opening and closing cycles within a 15 minute period.

Weapons Bay Door Auxiliary Switch.

The weapons bay door auxiliary switch, located on the stores control panel, is labeled BAY DOOR. The switch has two positions marked AUX and NORM. With the switch in the NORM position the weapons bay door operates on hydraulic pressure from the utility hydraulic system. Placing the switch to AUX provides electrical power to operate the weapons bay door.

Weapons Bay Door Control Switch.

The weapons bay door control switch, located on the stores control panel, has three positions marked OPEN, AUTO and CLOSE. The OPEN and CLOSE positions of the switch provide manual control of door operation by either normal hydraulic power or auxiliary electrical power depending on the position of the weapons bay door auxiliary control switch. The AUTO position functions in conjunction with the weapons bay door auxiliary switch. With the weapons bay door

auxiliary switch in the NORM position, the doors will automatically open approximately 10 seconds from release or 10,000 feet actual range from target (whichever is sooner), remain open until approximately one second after weapon release and then close. The doors will automatically operate with the weapons bay door auxiliary switch in the AUX position, however since the doors take 30 seconds to operate in this configuration, an automatic weapon release cannot be obtained.

WARNING

If the position of the bay door control switch is not in agreement with the position of the weapons bay doors, the doors may actuate to the commanded position when hydraulic and/or electrical power is applied to the aircraft.

Weapons Bay Door Position Indicator.

The weapons bay door position indicator, located on the stores control panel, is a flip-flop type indicator, which displays a cross hatched indication for intermediate weapons bay door positions or electrical power interruptions, or OPEN or CLOSE for those positions.

ATTACK RADAR (AN/APQ-114).

The attack radar provides all weather operation for aid to navigation, bombing and air refueling rendezvous capability. See figure 1-53 for attack radar system tie-ins with other weapon system avionic equipment. The set performs the following functions:

- Ground mapping.
- Navigation fixtaking.
- Air-to-air search and tracking.
- Air-to-air rendezvous.

The system may be operated in three ground modes, an air mode and a beacon mode. The beacon mode can be selected in either the air or ground modes. Basic components of the system consist of an antenna, an antenna roll unit and antenna control, located in the radome and a modulator-receiver-transmitter (MRT) and synchronizer, located in the forward electronic bay. The radar scope and the controls, including the tracking control handle, are located at the right crew station. A recording camera is provided to take radar scope photographs. The antenna is automatically stabilized in pitch and roll by signals from the bomb nav system. In the event of a bomb nav system failure, the antenna is stabilized in roll only by signals from the auxiliary flight reference system (AFRS). The antenna can be caged in the event of pitch or roll stabilization failure to be in alignment with the aircraft longitudinal and lateral axis by means of the antenna cage pushbutton; however, the antenna will continue to sector in azimuth and tilt can be adjusted. For location of the antenna, see figure 1-55. The MRT operates in the J frequency band of 16 to 16.55 GHZ and has the capability of automatic frequency control (AFC-1 and AFC-2) along with manual frequency control (MFC). In the AFC-1 position the receiver operates in the automatic frequency control mode and the transmitter sweeps through the frequency band with random reversal. This provides a measure of immunity to many types of jamming and improves stability of the scope display. When operating in AFC-2 the receiver operates in the automatic frequency control mode and the transmitter is manually tuned. In the event of a malfunction of AFC-1 or AFC-2 the MFC position is used. In this position the transmitter operates on mid-band fixed frequency and the receiver is manually tunable by adjusting the knob over the MFC range tracking. The beacon mode of operation enables the attack radar to interrogate and receive replies from J-band transponders. This capability enables long range detection and identification of aircraft for rendezvous and in-flight refueling. The scope panel contains the radar scope, recording camera, and the necessary operating and tuning controls for the scope and camera. The recording camera is mounted behind the radar scope. A small window in the side of the cathode ray tube allows the camera to take exposures of the back of the radar scope. The image on the scope is reversed by optics so that the film exposure will represent the scope presentation as seen by the operator. A film exposure is taken automatically at weapon release on a signal from the bomb nav system or manually when desired. Automatic scope photography is provided to take scope pictures at rates of either 1 exposure each 40 scans to 1 exposure each 4 scans depending on the function select knob position. A lamp on the radar scope panel will blink each time an exposure is taken. A film magazine in the face of the radar scope panel provides a minimum of 1200 exposures of 35 millimeter film. A readout window on the magazine shows percentage of film remaining. The magazine is installed or removed by means of a handle recessed in the front of the magazine. Simultaneous film exposure of a clock, data slate and 12 code lamps is made with each scope exposure to identify each frame of the film as shown in figure 1-54. The clock and slate provide time of exposure and operator's name, date, mission, etc. The tracking control handle is used in conjunction with the bomb nav system to position the azimuth and range cursors for fix taking, bombing and antenna tilt control in the air mode. Self test features incorporated into the system are used for preflight and maintenance malfunction analysis and troubleshooting. The system operates on 115 volt ac power from the left main ac bus and 28 volt dc power from the main dc bus.

Attack Radar Subsystem Tie-Ins

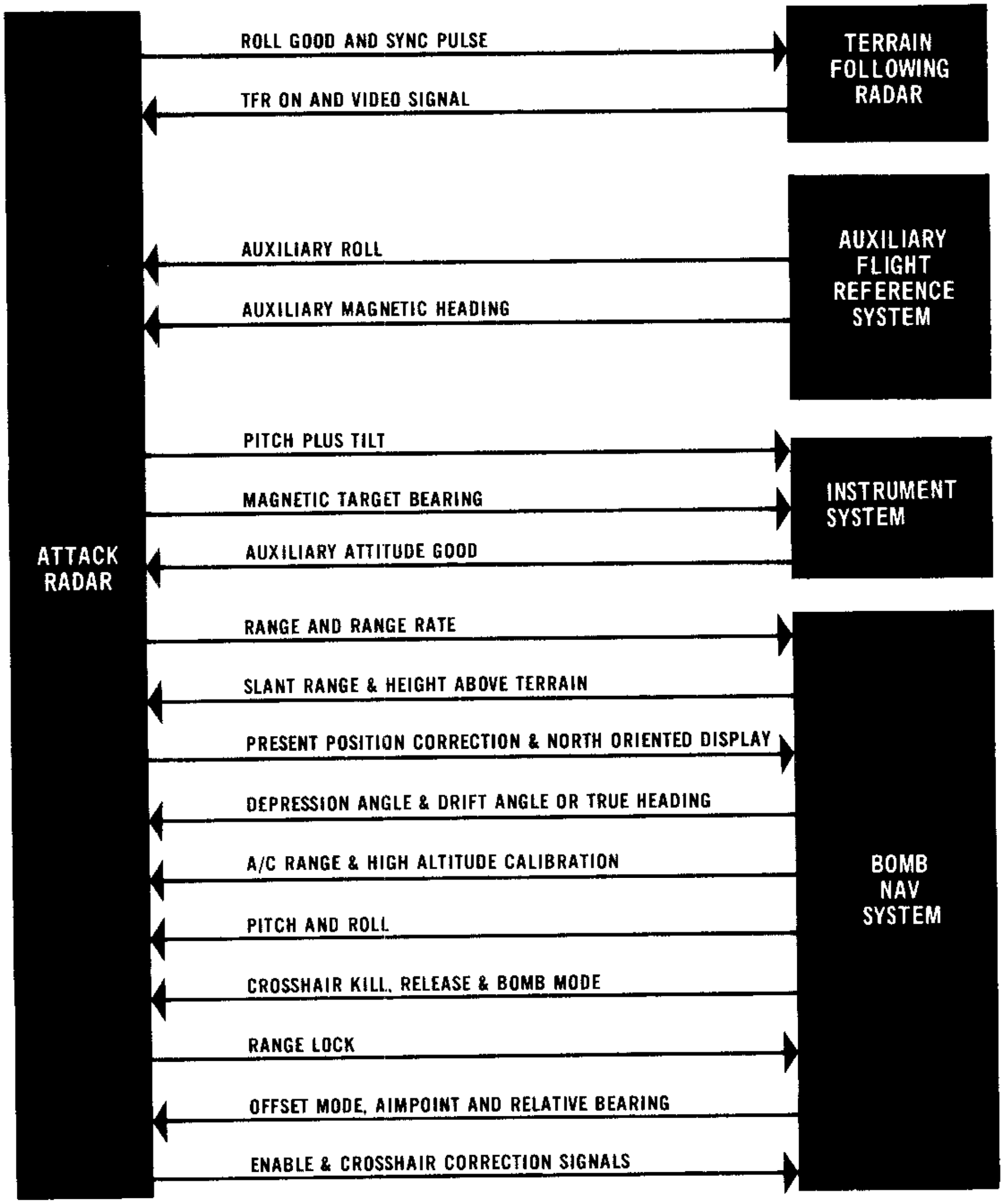

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Figure 1-53.

Photo Data Recording

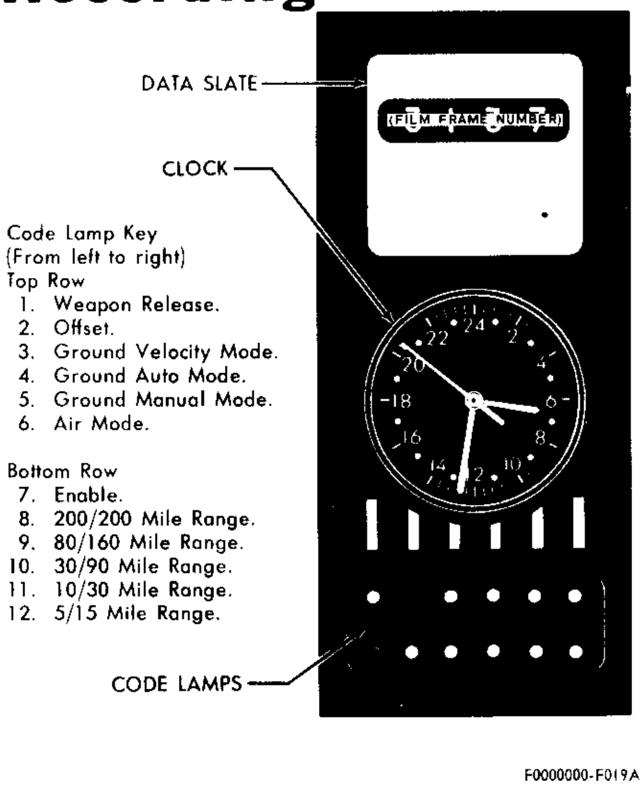


Figure 1-54.

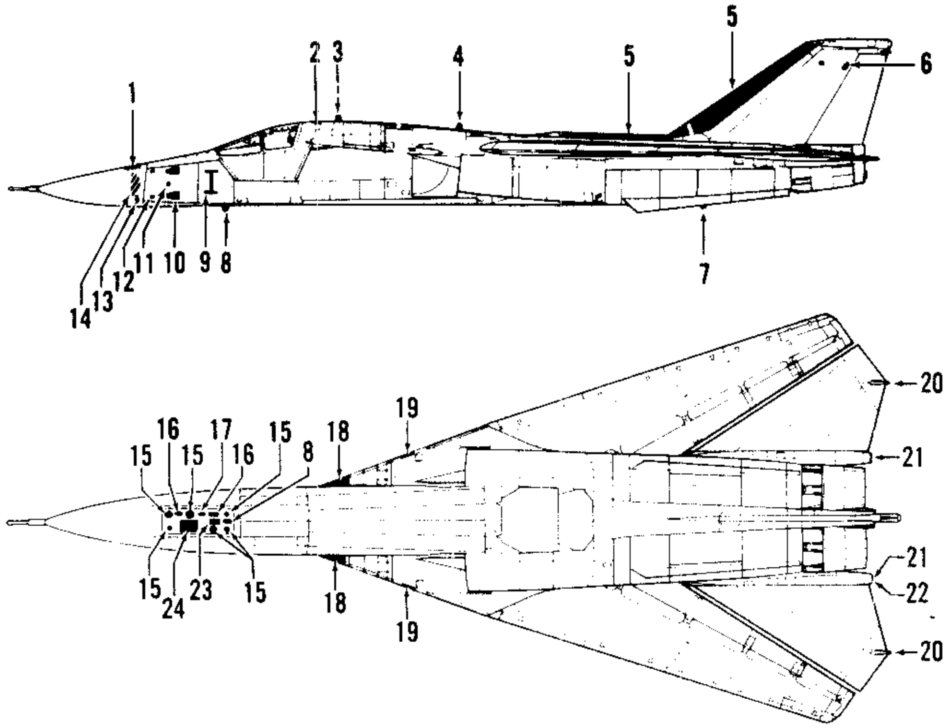
ATTACK RADAR GROUND MODES.

Three ground modes of operation are provided for ground mapping, fixtaking, and weapon delivery. The ground modes are: ground manual (GND MAN), ground auto (GND AUTO) and ground velocity (GND VEL). In all ground modes the antenna scans with a fan beam ±45 degrees centered about the longitudinal axis. In the ground auto mode the display is a ground-track stabilized, or north oriented stabilized one-radius-offset PPI display. The bomb nav system supplies the radar with continuously computed signals which represent slant range and relative bearing of a point which may be a target, aiming point, or fixpoint, depending upon the mode of operation of the bomb nav system. These signals enable the radar to generate synchronous range and azimuth cursors (cross-hairs) which, for an errorless input, will appear exactly on the radar image of the desired point and will maintain track with the point as it moves relative to the aircraft. The azimuth cursor is positioned within ±45 degrees in azimuth by the relative bearing signals supplied from the bomb nav system. The range cursor is positioned from approximately zero nautical miles to 124 nautical miles in response to the computed slant-range-to-target signal supplied by the bomb nav system. Fore or aft movement of the tracking handle, when the tracking handle enable switch is also depressed, will cause correction signals to be sent to the bomb nav system to adjust the computed along-track target position; these signals will represent north-south corrections for the north-oriented display. Similarly, when the enable switch is depressed a left or right motion of the tracking handle will cause correction signals to be sent to the bomb nav system to correct the computed cross-track target position; these signals represent east-west corrections for north-oriented display. The present position correction switch is used in conjunction with the bomb nav system to permit present position correction. Present position is corrected when the bomb nav system is in the navigation mode by placing the present position correction switch to IN and moving the tracking handle so that the intersection of the radar cross-hairs coincides with the target. If the present position correction switch is placed to OUT, when operating in the navigation mode no movement of the radar cursors is possible by use of tracking handle movement signals. When the bomb nav system is in the bomb mode, the cursors are automatically placed on target. In this mode, if the present position correction switch is set to the OUT position corrections are made by the tracking handle to the aircraft-target relationship and no correction to present position is made. If the present position correction switch is placed to IN while in bomb mode, movement of the tracking handle results in corrections to both the aircraft target relationship and the computed value of present position. In the ground velocity mode the range and azimuth cursors will appear in the center of the display. The slant range and relative bearing to the target destination or offset are supplied by the bomb nav system and are used to drive the display so that the target or destination point will remain centered under the crosshairs in the center of the scope display. In the ground manual mode the display is a ground-track stabilized, one radius-off-set PPI display and can operate independent of the bomb nav system. In the ground manual mode with the antenna caged, the scope display is not ground track stabilized. In this situation, zero degrees on the radar scope represents the aircraft heading. The range and azimuth cursors are manually positioned by use of the tracking handle. The range of the cursor can be read on the radar scope panel range counter.

ATTACK RADAR AIR MODE.

The air mode is provided for long range contact, identification and tracking of aircraft for rendezvous and air refueling. However, this mode could be utilized for air-to-air attack should the aircraft be equipped with guns and missiles. In the air mode an overlapping two-bar box scan is provided. In wide scan the antenna scans an area ±45 degrees about the longitudinal axis

Antenna Locations



1. Glide Slope.
2. Radio Beacon Set
3. UHF No. 2 and IFF.
4. TACAN and UHF No. 1.
5. HF
6. I-Band Radar Transponder.
7. UHF No. 2 and IFF.
8. TACAN and UHF No. 1.
9. Localizer (2).
10. H1 and H2 Radar Homing (4).
11. H3 Radar Homing (4).
12. High Frequency Radar Homing (4).
13. TFR (2).
14. Attack Radar.
15. AN/ALQ-94 (6).
16. Radar Altimeter (2).
17. AN/ALR-41.
18. AN/ALQ-94 (12).
19. AN/ALR-41 (4).
20. Aft Radar Warning (6).
21. AN/ALQ-94 (6).
22. AN/ALR-41 (1).
23. Marker Beacon.
24. Doppler Radar.

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Figure 1-55.

of the aircraft and can be positioned ±30 degrees in elevation. In narrow scan the antenna scans an area ± 10 degrees about the azimuth cursor. Wide scan is utilized for search and initial tanker position detection. Once the tanker is located, narrow scan can be selected to automatically track the tanker and provide the pilot with steering commands for the rendezvous. In order to track a target, the azimuth cursor must be positioned to within 10 degrees of the target. Actuation of the sector switch on the tracking handle provides the narrow scan and automatically activates the automatic range search and target acquisition circuitry. In the air mode, the IF gain is a fixed value unless the attack radar is in the beacon mode.

BEACON MODE.

The beacon mode of operation enables the attack radar to interrogate and receive replies from J-band transponders. The beacon mode of operation can be selected in both the air-to-ground and air-to-air modes. Once the beacon mode is selected, all normal targets and ground clutter will disappear from the radar scope, since the transmitter and receiver are tuned to different frequencies. Targets, if present will be transponder replies to the radar pulse interrogation. Once a transponder reply is noted on the scope, the operator can identify the target by reading the reply code. As a transponder target closes range, the transponder reply may be used for lock on and tracking by switching to air mode of operation and employing the target track procedures.

CONTROLS AND INDICATORS.

Radar Function Knob.

The radar function knob (3, figure 1-56), located on the attack radar control panel, has five positions marked OFF, STBY, ON, XMIT, and TEST. In the OFF position the entire system is de-energized. Placing the knob to STBY supplies power to all system filaments for warm-up and energizes a 40 second warmup delay and a 5 minute transmitter warmup delay. Also the antenna is caged in pitch and stowed full up in tilt and full left in azimuth. Placing the knob to ON energizes the entire system, except for the transmitter, after the 40 second warmup delay has expired. The knob must remain in the ON position for the 5 minute mandatory warmup period after which it may be placed to XMIT to place the entire system in operation. The TEST position allows self test of the system for malfunction troubleshooting and ground maintenance.

Note

After the radar function knob is turned from STBY to either ON, XMIT, or TEST, the mode selector knob should be placed briefly in the GND AUTO or GND VEL position. This action provides a master reset. Master reset is an internally generated signal that places the attack radar computer circuitry in a known state of valid operation. Necessity for reset may be indicated by an abnormal radar display such as distorted display, cursor hangup, or erratic range readout.

Attack Radar Mode Selector Knob.

The attack radar mode selector knob (1, figure 1-56), located on the attack radar control panel, has four positions marked GND MAN (ground manual), GND AUTO (ground auto), GND VEL (ground velocity) and AIR. In the GND MAN position, the range and azimuth cursors are positioned with the tracking control handle and antenna tilt is positioned with the antenna tilt control knob independently of the navigation computer. In the GND AUTO position, the cursors are automatically positioned and the antenna tilt normally is automatically positioned by signals from the bomb nav system. The tracking control handle is used to correct the bomb nav system present position and the tilt control knob is used to refine the scope display. Operation in the GND VEL position is the same as in the GND AUTO position except the scope display is a ground velocity stabilized magnified picture and the intersection of the cursors remains in the center of the scope display. In the AIR position, the antenna is programmed for a box scan which can be raised or lowered in elevation with the tracking control handle during search, detection, and acquisition of an air target. Once a target has been acquired by the radar, tracking is automatic in range, azimuth, and elevation.

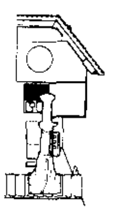
Note

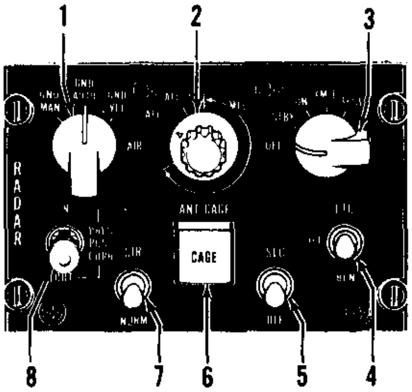
When rotating the attack radar mode selector knob allow one second for each mode. Rapid cycling of the mode selector knob through two or more modes may produce conditions requiring an additional master reset action.

Attack Radar Frequency Control Knob.

The frequency control knob (2, figure 1-56), located on the attack radar control panel, has three positions marked AFC 1 (automatic frequency control), AFC 2, and MFC (manual frequency control). In the AFC 1 position the receiver operates in the automatic frequency control mode and the transmitter operates in a frequency agility mode in which the transmitter sweeps through the frequency band with random reversal. The changing frequency and rapid scanning rate provided in this position provides immunity to many types of jamming and improves stability of the PPI display. In the AFC 2 position the receiver operates in the automatic frequency control mode and the transmitter frequency is manually changed using the transmitter tuning control knob. The MFC position of the knob is variable over a range between the 12 and 8 o'clock position. In this position the transmitter operates in a mid-band fixed frequency and the receiver is manually tunable by adjusting the knob over the MFC range.

Attack Radar Control Panel





1. Mode Selector Knob.
2. Frequency Control Knob.
3. Radar Function Knob.
4. Fast Time Constant/Beacon Switch.
5. Side Lobe Cancellation Switch.
6. Antenna Cage Pushbutton Indicator Lamp.
7. Antenna Polarization Switch.
8. Present Position Correction Switch.

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Figure 1-56.

Attack Radar Fast Time Constant/Beacon Switch.

The fast time constant beacon switch (4, figure 1-56), located on the attack radar control panel, has three positions marked FTC (fast time constant), OFF, and BCN (beacon). Placing the switch in the FTC position provides leading edge discrimination of all returns. This discrimination highlights the leading edge of targets, blanks out the trailing edge, and provides a much clearer assessment of the relative position or pattern of the complex. The FTC position is used to minimize the effects of jamming in any mode of operation.

Note

The FTC position should be used in air mode of operation only when obvious jamming signals are present on the attack radar scope display.

The BCN position places the system in beacon mode of operation and can be selected in both air and ground modes. This mode enables the attack radar to interrogate and receive replies from J-band transponders. *Once the beacon mode is selected, all targets except the transponder replies will disappear from the scope display.*

Attack Radar Side Lobe Cancellation Switch.

The side lobe cancellation (SLC) switch (5, figure 1-56), located on the attack radar control panel, is a two position switch marked SLC and OFF. Placing the switch to the SLC position will cancel the energy received from the side lobes of the radar beam to reduce ground clutter. The SLC position may be selected in any mode of operation; however, it is most effective when operating in the air mode at low altitudes.

Antenna Polarization Switch.

The antenna polarization switch (7, figure 1-56), located on the attack radar control panel, is a two position switch marked CIR (circular) and NORM. With the switch in the NORM position antenna polarization is horizontal when operating in the ground mode and vertical when operating in the air mode. Placing the switch to CIR changes antenna polarization to circular when operating in either ground or air modes. The CIR position may be used to reduce rain clutter interference on the scope. The polarization is always horizontal for beacon mode of operation.

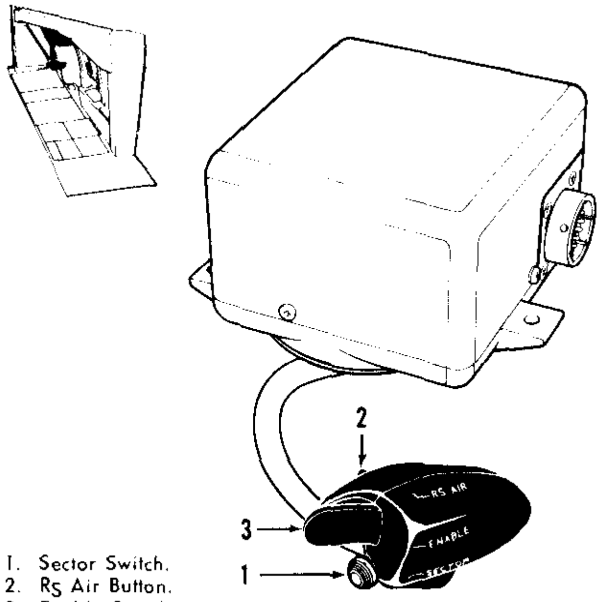
Present Position Correction Switch.

The present position correction switch (8, figure 1-56), located on the attack radar control panel, is a two position switch marked IN and OUT. The switch is used in the ground auto and ground velocity modes of operation when correcting the bomb nav system present position counters, with the tracking handle.

Attack Radar Tracking Control Handle.

The tracking control handle (figure 1-57) is mounted on a pivot pedestal on the right side of the right crew station. An enable switch located on the handle must be depressed and held to activate the handle. When operating in the air mode with the range search button depressed, or the ground manual mode, fore or aft displacement of the handle will slew the range

Attack Radar Tracking Control Handle



1. Sector Switch.
2. R_S Air Button.
3. Enable Switch.

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Figure 1-57.

cursor out or in respectively. When operating in the normal ground auto or ground velocity mode, fore or aft displacement will slew the cursor intersection in a direction parallel to aircraft ground track. For north-oriented display operation, this will move the cursor intersection point north or south. Moving the handle to a fore or aft position in the air mode without depressing the range search button will adjust antenna elevation down and up respectively. When operating in the air or ground manual mode, left or right displacement of the handle will slew the azimuth cursor left or right. When operating in the normal ground auto or ground velocity mode, left or right displacement will slew the cursor intersection in a direction perpendicular to aircraft ground track and will move the cursor intersection point west or east for north-oriented display operation. Slewing speed is proportional to the amount of handle deflection.

Attack Radar Range Search (R_S) Button.

The red range search button (2, figure 1-57), located on the top of the tracking control handle is labeled R_S AIR. The button is used in the air mode of operation and when depressed causes the radar set to break lock. With the sector switch (1, figure 1-57) in the aft

position (wide antenna scan), depressing the range search button permits the range cursor to be slewed rapidly to any desired position on the sweep (to a maximum range of 124 nautical miles) by moving the tracking handle fore or aft. When the button is released, the range cursor will remain stationary after slewing. With the sector switch in the forward position narrow scan), depressing the range search button overrides range lock (if established) and permits the range cursor to be slewed rapidly to any desired position on the sweep (to a maximum range of 124 nautical miles) by moving the tracking handle fore and aft. When the button is released, range searching will resume from the point at which the range cursor was positioned by slewing.

Attack Radar Sector Switch.

The sector switch (1, figure 1-57), located on the left top of the tracking control handle, is labeled SECTOR and is a two position, thumb actuated, toggle switch. The switch is used in either the ground or air modes of operation to change the sector of antenna sweep. In the aft position (wide scan) antenna sweep is ±45 degrees about the longitudinal axis of the aircraft. In the forward position (narrow scan) antenna sweep is ±10 degrees about the azimuth cursor. In addition, the forward position causes the initiation of automatic acquisition and tracking in the air mode.

Photo Mode Selector Switch.

The photo mode selector switch (7, figure 1-58), located on the attack radar scope panel. is a three position switch marked AUTO, MAN (manual) and OFF. The switch is spring loaded from MAN to OFF. A film exposure is taken when the switch is held to the MAN position. With the switch in AUTO, film exposures will be taken automatically at a rate of one photo per each 40 antenna scans or one photo per each four antenna scans when radar bomb mode is selected on the bomb nav control panel. Regardless of switch position, a film exposure is taken automatically at weapon release on signal from the bomb nav system.

Intermediate Frequency Gain Knob.

The intermediate frequency gain knob (21, figure 1-58), located on the attack radar scope panel, is labeled IF GAIN and permits adjustment of receiver gain when operating in the ground modes. This control determines maximum usable sensitivity of the receiver circuits and functions primarily as a brightness control. It can best be set without the transmitter firing (function selector in the ON position), but in order to set IF gain the video gain control must be advanced to a position to allow noise video to be painted on the scope even though the optimum setting of the video gain control must be made with the function selector knob in XMIT. This control is also operative in air mode if BCN is selected.

Antenna Tilt Control Knob.

The antenna tilt control knob (10, figure 1-58), located on the attack radar scope panel, provides a means of manually adjusting antenna tilt position when operating in the ground modes. The knob is labeled ANT TILT. In the ground manual mode the knob is the only means of adjusting antenna tilt. In the ground auto and ground velocity modes antenna tilt is automatically positioned by signals from the bomb nav system and the knob is used to refine this position. The knob has a detent corresponding to zero antenna tilt position for reference when the radar is operating in ground manual mode, or operating in ground auto or ground velocity mode with the beta switch in the MAN position. The detent indicates zero tilt correction when the radar is operating in ground auto or ground velocity mode with the beta switch in the NORM position. Rotating the knob fully counterclockwise tilts the antenna up to +30 degrees and rotating the knob fully clockwise tilts the antenna down to −30 degrees. However, with the terrain following radar (TFR) operating, the antenna can only be physically adjusted to −8 degrees (pitch plus tilt) to prevent interference with the TFR. Antenna position is indicated on the antenna tilt indicator (20, figure 1-58), located on the attack radar scope panel. The indicator is graduated in 5 degree increments from zero to ±30 degrees. The knob has no control over antenna tilt when operating in the air mode.

Attack Radar Scope Intensity Control Knob.

The attack radar scope intensity control knob (15, figure 1-58), located on the attack radar scope panel, is labeled CRT INT. The knob provides an adjustment of scope baseline intensity from zero to full brightness. To set the CRT intensity properly, operate the radar with the function selector in the ON position with the IF GAIN and VIDEO controls fully CCW. Advance the knob clockwise (increasing brightness) to a point where the sweep is on the ragged edge between being visible and invisible.

Bezel/Range Marks Intensity Control Knobs.

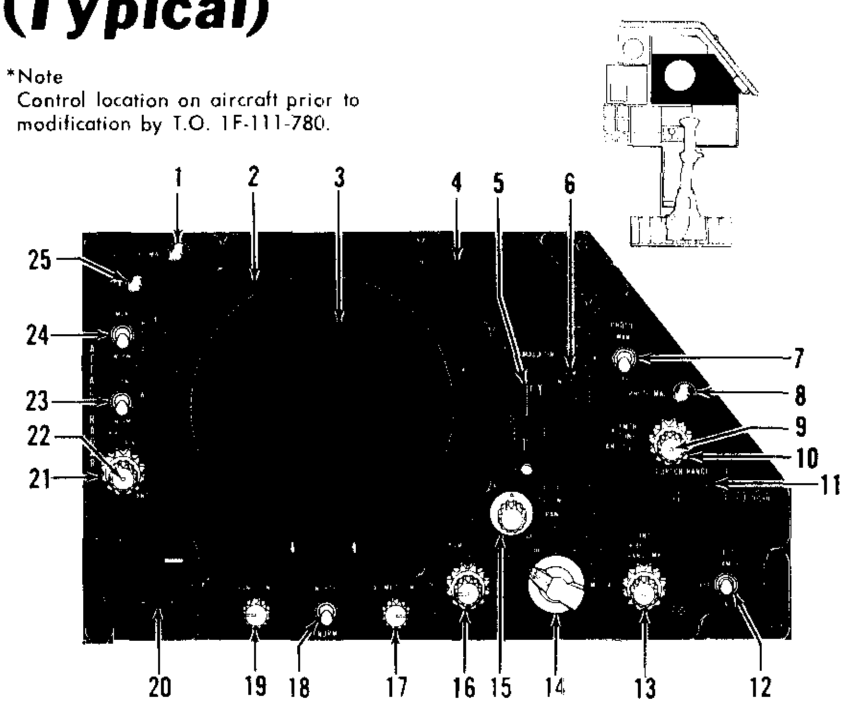
Two coaxial knobs (13, figure 1-58), located on the attack radar scope panel, provide an adjustment of bezel and range marks intensity. The knobs are labeled INT. The outer knob is marked BEZEL, and the inner knob is marked RANGE MK. Turning either knob clockwise increases intensity from zero to full brightness. The range mark intensity should normally be adjusted at a slightly different level from the range cursor intensity to prevent confusion.

Range and Azimuth Cursor Intensity Control Knobs.

Two cursor intensity control knobs (17, 19, figure 1-58), located on the attack radar scope panel, provide an

Attack Radar Scope Panel (Typical)

*Note
Control location on aircraft prior to modification by T.O. 1F-111-780.



1. System Malfunction Lamp.
2. Azimuth Bezel.
3. Radar Scope.
4. Ground Adjustment Access Door.
5. Film Magazine Removal Handle.
6. Unused Film Indicator.
7. Photo Mode Selector Switch.
8. Photo Malfunction Indicator Lamp.
9. Transmitter Tuning Control Knob.
   * (Intermediate Frequency Gain Control Knob)
10. *Antenna Tilt Control Knob.*
11. Cursor Range Counter.
12. Test Switch.
   * (Sensitivity Time Control Knobs)
13. Bezel/Range Marks Intensity Control Knobs.
   * (Video Adjustment Knob)
   * (Transmitter Tuning Control Knob.)
14. Range Selector Knob.
15. Scope Intensity Control Knob.
16. Sensitivity Time Control Knobs.
   * (Bezel Range Marks Intensity Control Knobs)
17. Azimuth Cursor Intensity Control Knob.
18. North Orientation Selector Switch.
19. Range Cursor Intensity Control Knob.
20. Antenna Tilt Indicator.
21. Intermediate Frequency Gain Control Knob.
22. Video Adjustment Knob.
   * (Test Switch)
23. Sweep Control Switch.
24. Beta Switch.
25. Range Lock Indicator Lamp.

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Figure 1-58.

adjustment or range and azimuth cursor intensity. The knobs are labeled individually as RANGE INT and AZIMUTH INT. Turning either knob clockwise increases intensity of the respective cursor from zero to full brightness. Adjustment of the range and azimuth cursor intensity to the lowest usable value will allow more precise placement of the cursors over the target.

North Orientation Selector Switch.

The north orientation selector switch (18, figure 1-58), located on the attack radar scope panel, is a two position switch marked NORTH and NORM. When the switch is placed to NORTH position, top of the radar scope is true north oriented. The north stabilized display is employed only in the ground auto and ground velocity modes of operation. Placing the switch to NORM permits normal scope display presentation.

Attack Radar Test Switch.

The three position test switch (12, figure 1-58), located on the attack radar scope panel, is labeled TEST. The switch is marked LAMP, CKT and OFF. The switch is spring loaded to OFF position. The LAMP position is used to check all the indicator lamps on the scope panel. The CKT position is used to make maintenance ground confidence checks to the system.

Attack Radar Sweep Control Switch.

The sweep control switch (23, figure 1-58), located on the attack radar scope panel, is a two position switch marked SLANT and NORM. The switch is used in the ground modes of operation to provide a map-like presentation in the NORM position and a linear presentation in the SLANT position. The switch is inoperative in the air mode.

Attack Radar Beta Switch.

The beta switch (24, figure 1-58), located on the attack radar scope panel, is a two position switch marked MAN (manual) and NORM. The switch functions in the ground auto and ground velocity modes to select automatic sighting angle in the NORM position and manual sighting angle in the MAN position. In the normal position, sighting angle is automatically positioned by signals from the bomb nav system and the antenna tilt control knob can be used to refine this position. In the MAN position sighting angle is adjusted with the antenna tilt knob. The switch is inoperative in the ground manual and air modes of operation.

Sensitivity Time Control Knobs.

Two coaxial rotary sensitivity time control (STC) knobs (16, figure 1-58), located on the attack radar scope panel, provide a means of equalizing radar intensity over the entire scope display when operating in the ground modes at low altitude. The outer knob labeled AMPL/OFF, has an OFF position at nine o'clock, and is used to obtain an initial adjustment of display intensity or to turn the STC function OFF in the event of a malfunction in the STC circuit. The STC function is fixed in air mode but must be turned on with the outer knob. The inner knob, labeled SLOPE, is used to balance the display intensity throughout the sweep. The STC slope function is inoperative in the air mode. The STC function is inhibited in beacon mode. With STC on, an altitude compensation signal is provided to maintain even ground paint as long as the toe of the antenna beam remains at 80 nautical miles. With the toe of the beam at shorter distances, the slope and amplitude controls must be adjusted for compensation. The amplitude control sets the receiver sensitivity level at zero range and the slope control adjusts the time required after zero range for the receiver to regain full sensitivity. This time would be less if the toe of the beam was on a point 30 miles ahead of the aircraft than for a condition with the toe 80 miles ahead.

Video Adjustment Knob.

The video adjustment control knob (22, figure 1-58), located on the attack radar scope panel, provides a means of adjusting the video signal. The knob, labeled VIDEO, is used to increase the amplitude of the video signal supplied to the attack radar scope when it is turned clockwise. The video control determines the brightness of target returns as opposed to the CRT intensity control setting the overall baseline brightness of the scope. To set the video control properly, advance the function knob to XMIT and adjust antenna tilt to see the most returns on the scope. Adjust the video control until the target returns are sharp and bright against the picture background and give an overall optimum contrast to the picture. Video gain may need to be decreased slightly to prevent blooming of the target on a bomb run as the range decreases and the return grows stronger.

Transmitter Tuning Control Knob.

The transmitter tuning control knob (9, figure 1-58), located on the radar scope panel allows continuous tuning of the transmitter over its entire frequency range. The knob, labeled XMTR TUNE may be used when the frequency control knob is in the AFC 2 position.

Attack Radar Range Selector Knob.

The range selector knob (14, figure 1-58), located on the attack radar scope panel, allows selection of various scope display ranges. The knob is marked RANGE with 15, 30, 90, 160, and 200 mile positions on an outer scale and miles/diameter with 5, 10, 30, 80, and 200 mile positions on an inner scale. The inner scale is used in the GND MAN, GND AUTO and AIR modes to select desired scope range. The inner and outer scales are used in conjunction with each other in the GND VEL mode. The outer scale then determines maximum display range and the inner scale determines the diameter of the scope range being displayed about the cursors.

Attack Radar Scope.

The radar scope (3, figure 1-58) provides a sector scan plan position indicator (PPI) display with a fixed one radius offset sweep in all modes of operation except in ground velocity mode. In ground velocity mode the sweep is a variable offset with a maximum displacement of six radii. In normal stabilization the aircraft position on the scope is at the bottom in vertical alignment with the center of the scope. In north orientated stabilization the top of the scope display will be towards true north. The scope is 6 inches in diameter. The sector displayed is a 90 degree area ahead of the aircraft when in wide scan and a 20 degree area centered on the azimuth cursor when in narrow scan. An azimuth bezel (2, figure 1-58), around the top of the scope is graduated in one degree increments with each 10 degrees marked to show azimuth displacements up to 50 degrees either side of the aircraft heading or ground track. When operating in the air mode or when the antenna is caged in ground manual mode, zero degrees on the scale represents aircraft heading. In any of the ground modes the scan is displaced in azimuth to compensate for drift, and zero degrees represents ground track. North is vertical on the scope when north-orientation is selected. In the air to air tracking mode of operation two arrows in the bottom of the bezel indicate target vertical position relative to antenna scan. When both arrows are lighted the target is in the center of the scan. Range and azimuth cursors are displayed on the scope for fixtaking and target tracking. The cursors are positioned with the tracking control handle. Fixed range markers are provided for various ranges of operations. For 5, 10, 30, 80, and 200 ranges each range mark represents 1, 2, 5, 20, and 40 mile range increments respectively, except there are no range marks displayed in ground auto or ground velocity modes when in 5 and 10 or 15/5 and 30/10 range scales, respectively. Scope brilliancy and intensity of the bezel, cursors and range marks are controlled by knobs on the scope panel.

Note

During the air-to-ground ranging, the attack radar provides the TFR system with its computer function to compute the slant range to a ground point for use in the DCC. For the attack radar computer to accurately compute the air-to-ground range, it is necessary that the attack radar computer be synchronized with the TFR transmitter. The TFR, therefore, supplies the attack radar computer with a pulse indicating the fixing time of the TFR transmitter and a sample of the video to which the range is desired. The pulse from the TFR, indicating fixing time will determine when the sweep on the attack radar begins. However, the video dispay on the attack radar scope is provided by the attack radar receiver. Since the video and the sweep on the attack radar scope are not synchronized, a range error exists for any arbitrary returns displayed making the video presentation unsuitable for data extraction. The range readout on the attack radar will indicate the slant range to the video pulse supplied by the TFR. The tracking handle for the attack radar is rendered inoperative and the plan position indicator presentation on the TFR is blanked during air-to-ground ranging.

Attack Radar Cursor Range Counter.

The cursor range counter (11, figure 1-58), located on the attack radar scope panel, automatically indicates slant range in all modes of operation. The counter has four digital readout windows capable of indicating distances up to 799,900 feet in increments of 100 feet.

Attack Radar System Malfunction Lamp.

An amber system malfunction lamp (1, figure 1-58), located on the attack radar scope panel, provides the operator with an indication of a failure in the system. The lamp is labeled SYS MAL and will not light when the function selector knob is in the STBY position. The lamp will light indicating any of the following: (1) failure in the antenna system, or input to the antenna system; (2) failure in the transmitter system; (3) exceeding the roll limit of the antenna; (4) any time the combined antenna pitch plus tilt angle exceeds the vertical limits (vertical limits with TFR are −8 to +30 degrees); and (5) anytime the frequency control knob is moved to the MFC position, except during beacon mode operation, the lamp becoming a course tuning indicator.

Note

It will be normal for the attack radar system malfunction lamp to light intermittently during TFR operation.

If the system is not usable the function selector knob should be placed to STBY to stow the antenna.

Attack Radar Range Lock Indicator Lamp.

A green range lock indicator lamp (25, figure 1-58), located on the attack radar scope panel, is labeled LOCK and will light when a range lock is acquired on a target when operating in the air mode.

Photo Malfunction Indicator Lamp.

The amber photo malfunction indicator lamp (8, figure 1-58), located on the attack radar scope panel, is labeled PHOTO MAL and provides an indication ot camera operation or malfunctions. The lamp will blink each time a film exposure is made. The lack of a light indicates a camera shutter malfunction. A steady light indicates film breakage or failure of the film feed mechanism. If a photo malfunction occurs, the malfunction circuitry can be reset by cycling the radar through standby.

Note

In case of film stoppage, the malfunction can usually be cleared by removing the film magazine and manually turning the drive shaft two or three turns.

Unused Film Indicator.

The unused film indicator (6, figure 1-58), located on the attack radar scope panel, is a digital readout indicator that displays the percent of film remaining in the magazine. When the indicator reads 100 percent a maximum of 1300 frames of film is present.

Antenna Cage Pushbutton Indicator Lamp.

The antenna cage pushbutton indicator lamp (6, figure 1-56), located on the attack radar control panel, is labeled ANT CAGE. The pushbutton provides a means of caging the antenna and the lamp provides an indication that the antenna is caged, either due to manually pushing the button or due to failure of the automatic pitch and roll stabilization circuitry. Depressing the button will cage the antenna pitch and roll axes and align the antenna with the longitudinal and lateral axes of the aircraft; however, the antenna will continue to sector in azimuth, and tilt can be adjusted. When operating in the ground manual mode with the antenna caged the radar scope will display aircraft heading at zero degrees azimuth and range sweep will be slant range instead of ground range. When the antenna is caged a lamp in the button will light displaying the word CAGE. Depressing the button again after the antenna has been caged will uncage the antenna and the lamp will go out. Should the bomb nav system stabilization platform fail, the lamp will light and remain on until the system is switched to AUX reference.

Note

Do not cage the attack radar antenna during TFR operation. To do so will cause a fly-up.

Waveguide Low Pressure Pushbutton/Indicator Lamp.

The attack radar waveguide is pressurized to approximately 29 psi. This pressurization is to prevent arcing in the waveguide and subsequent damage to the magnetron. An amber pushbutton/indicator lamp, located under the attack radar ground adjustment access door, will light and the radar system will go into a standby condition in the event of a drop in waveguide pressure below approximately 23 psi. This circuit is operative only when the attack radar function knob is in the XMIT or TEST position. Opening the access door and depressing the lamp will override the standby condition and the radar system will return to a transmitting mode. The lamp will remain lighted until the waveguide pressure returns to normal. To decrease the effects of transmitting with reduced pressure, minimum transmit time techniques must be employed at altitudes as low as practicable. Radar range selection should be 30 NM or less if possible. If arcing indications are apparent, turn the radar function knob to ON and wait as long as possible between transmission cycles. Only under extreme conditions, such as avoiding thunderstorms or when present position is in doubt, should the attack radar be used above 8000 ft msl.

CAUTION

Transmitting with the attack radar with less than normal waveguide pressure will reduce the life expectancy of the radar system.

HORIZONTAL SITUATION DISPLAY SYSTEM.

Aircraft 53 ♦ are equipped with a horizontal situation display (HSD). The HSD functions in conjunction with the bomb nav system, CMRS and RHAWS to serve as an aid in navigation and weapon delivery. The system has the capability of displaying either aeronautical charts (maps) or data frames on a circular screen along with various symbols which provide pertinent information of mission status. Up to 50 charts or 100 data frames can be stored on film.

CHART PRESENTATIONS.

Chart presentations are actual aeronautical chart film reproductions projected on the screen to the same scale as the original chart. Inputs from the bomb nav system automatically move the position of the aircraft in the center of the screen along the chart to update present position; however, the operator can manually move the chart around on the screen if he desires to look at other areas of the map. The chart presentation can be operated in either heading up or a north up orientation. Symbols displayed on the screen during chart operation are depicted on figure 1-59. Symbols displayed during both automatic or manual chart presentation are as follows:

- Aircraft present position—Indicated by an aircraft symbol projected in the center of the chart.
- Aircraft ground track—Represented by a line passing through the aircraft symbol. When in the north-up display the ground track cursor indicates aircraft course.
- Compass rose—Displayed around the periphery of the viewing screen oriented in degrees and with cardinal compass points noted.
- Display index—A fixed diamond symbol shown at the top of the display. Indicates true aircraft heading when in the heading-up display mode.

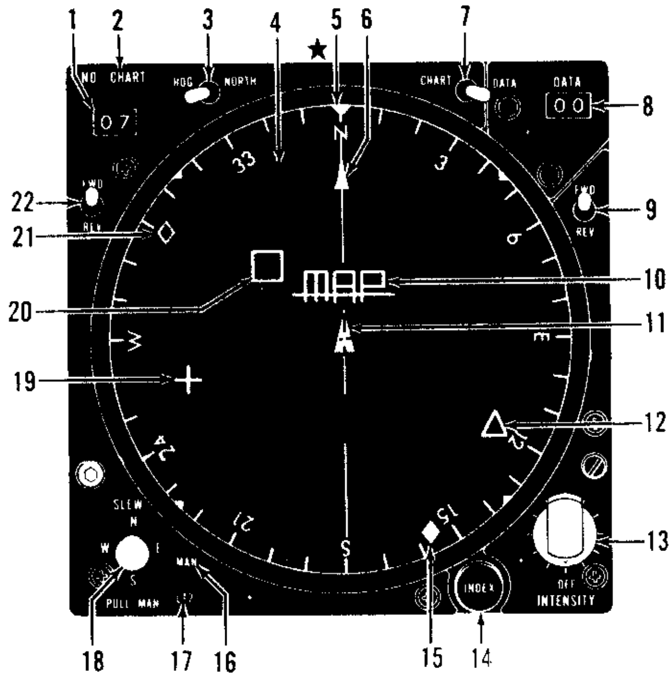
The following video symbols may appear on the chart presentation during automatic operation. During manual operation these symbols will not be displayed.

- Chart drive fail—The map fail symbol is displayed when the system self test logic indicates a malfunction in the map drive mechanism.
- Designation cursor—The cursor coordinates are the same as the cross-hair coordinates of the attack radar, and are displayed whenever the coordinate point is within the HSD field of view.
- Destination/aimpoint—When in a bomb nav system navigation mode three destination/aimpoints may be displayed. When in a bomb nav system weapon delivery mode, two destination/aimpoints may be displayed and represent the offsets associated with the target in use.
- Radar threat—The radar threat symbol is displayed when the RHAWS set is in the homing mode and is locked on a radar target or a RHAW fixtaking mode is selected. A flashing symbol indicates the RHAW lock on of the target has been broken.

The symbol is displayed in azimuth around the periphery of the compass rose. The radar threat symbol is blanked in the RHAW designation mode.

- IR Threat—The IR threat symbol is displayed adjacent to the compass rose. The IR threat symbols are always displayed at the bottom of the display which represents the tail of the aircraft.
- Target Symbol—The target symbol represents the next target in the sequence.
- Strobe line—The line which extends from near the inner edge of the compass rose graduation marks toward the aircraft symbol approximately $\frac{3}{4}$ of an inch. In the heading up mode the line represents

Horizontal Situation Display (Typical)



1. Chart Number Readout Window.
2. NO Chart Indicator.
3. Heading/North Up Switch.
4. HSD Display Screen.
5. Display Index.
6. Ground Track.
7. Chart/Data Selector Switch.
8. Data Frame Number Readout Window.
9. Data Frame Switch.
10. Chart Drive Failure.
11. Aircraft Symbol.
12. Target.
13. Power/Intensity Control Knob.
14. Index Pushbutton.
15. IR Threat.
16. Manual Indicator Lamp.
17. Secondary Lamp Indicator.
18. Slew Switch.
19. Designation Cursor.
20. Navigation Destination/Offsets.
21. Radar Threat.
22. Chart Frame Switch.

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Figure 1-59.

bearing to the destination, target or designation point. In the north-up mode the line represents aircraft heading.

DATA FRAME PRESENTATION.

Data frame presentations are independent of chart presentation. Data frame presentations are film strips of any type of data that can be photographically reproduced on to film. Data provided on data frames normally would be check lists, handbook information, briefing material, mission profiles, etc. Data frames are numbered from 1 thru 100 and can be rapidly slewed to select the desired frame. Data frame number 50 always contains emergency information, and can be immediately selected by depressing an index pushbutton. There are no symbols displayed with the data frames. While using data frame presentations the HSD will automatically keep the chart presentations current with respect to aircraft position.

CONTROLS AND INDICATORS.

Power/Intensity Control Knob.

The power/intensity control knob (13, figure 1-59), located on the HSD panel is labeled INTENSITY. The knob has a marked OFF position. Rotating the knob clockwise out of the OFF position provides power to the system and varies the intensity of the display. Clockwise rotation increases the intensity and vice versa.

Index Pushbutton.

The index pushbutton (14, figure 1-59), located on the HSD panel is marked INDEX. The pushbutton is used for selecting emergency data frame number 50. Depressing the pushbutton will slew frame number 50 into view regardless of selected mode. When the pushbutton is depressed a lamp will light displaying the letters INDEX. Depressing the pushbutton a second time will return system to last selected mode.

Heading/North Up Switch.

The heading/north-up switch (3, figure 1-59), located on the HSD panel has two positions marked HDG and NORTH. When the switch is positioned to HDG the heading displayed on the compass rose opposite the fixed reference index is true heading. When the switch is in NORTH position the compass rose displays true north.

Chart/Data Selector Switch.

The chart/data selector switch (7, figure 1-59), located on the HSD panel has two positions marked CHART and DATA. When the switch is positioned to CHART chart presentations are displayed. When the switch is positioned to DATA, data frames are displayed.

Chart Frame Switch.

The chart frame switch (22, figure 1-59), located on the HSD panel has three positions marked FWD (forward), REV (reverse) with an unmarked center off position. The switch is spring-loaded to off. Holding the switch to FWD or REV will drive the chart in the desired direction. The speed at which the chart is driven is controlled by the amount of pressure applied to the switch.

Data Frame Switch.

Data frame switch (9, figure 1-59), located on the HSD panel has three positions marked FWD (forward), REV (reverse) with an unmarked center off position. The switch is spring-loaded to off. Holding the switch to FWD or REV will drive the data frames in the desired direction. The speed at which the frames are driven is controlled by the amount of pressure applied to the switch.

Slew Switch.

The slew switch (18, figure 1-59), located on the HSD panel is labeled SLEW. The switch has five positions marked N (north), E (east), S (south), W (west), and an unmarked center position. The switch is a push-pull type switch and must be pulled out to manually position the chart in the desired direction. The switch is spring-loaded to the neutral position in manual. During manual operation the manual indicator lamp (16, figure 1-59), will light displaying the letters MAN. Depressing the switch returns the chart presentation to automatic operation. Selecting manual will cause the display to assume a north-up presentation regardless of the position of the heading/north-up switch.

Data Frame Number Readout Window.

The data frame number readout window (8, figure 1-59), located on the HSD panel is labeled DATA. The window will indicate the frame number in use. The numbers range from 00 to 99.

Chart Number Readout Window.

The chart number readout window (1, figure 1-59), located on the HSD panel is labeled CHART. The window indicates the chart number in use. The numbers range from 00 to 50.

Manual Indicator Lamp.

A green manual indicator lamp (16, figure 1-59), located on the HSD panel, is provided to indicate that the chart presentation can be positioned manually. The lamp is labeled MAN, and will light when the slew switch is pulled out.

Secondary Lamp Indicator.

A secondary lamp indicator located on the HSD panel (17, figure 1-59), will light when the second chart projection lamp is being utilized. When lighted LT 2 is visible in the indicator.

No Chart Indicator Lamp.

A no chart indicator lamp (2, figure 1-59), located on the HSD panel is provided to indicate the aircraft's present position is not on the chart being displayed. When lighted the word NO is displayed.

RADAR ALTIMETER SYSTEM (AN/APN-167).

The radar altimeter system is a dual channel low altitude radar system which provides precise absolute altitude, rate of altitude change and preselected minimum altitude warnings. Absolute altitude from 0 to 5000 feet is read on the radar altimeter indicator. Rate of altitude change from 0 to 500 feet per second is furnished to the terrain following radar. Minimum altitude fly-up signals are provided to the integrated flight instruments in the ILS and AILA mode of instrument system coupler operation. The system is composed of two receiver-transmitter (RT) units; two antennas, one for transmitting and one for receiving; a distribution box; a radar altimeter indicator and the necessary controls. The RT units are located in the forward electronic equipment bay. When the system is placed in operation, one RT unit is activated and the other is in standby for use in the event the operating unit malfunctions. In the event of a malfunction the standby RT unit must be manually selected. The RT unit in operation is connected to the antennas and its outputs are distributed to other aircraft systems by circuits in the distribution box. The radar altimeter will break lock if the bank angle exceeds 45 degrees or if pitch angle exceeds ±20 degrees. The system incorporates a self-test feature for checking reliability. The system operates on 115 volt ac power from the left main ac bus and 28 volt dc power from the main dc bus. Refer to figure 1-55 for antenna location.

RADAR ALTIMETER CHANNEL SELECTOR SWITCH.

The radar altimeter channel selector switch (5, figure 1-60), located on the miscellaneous switch panel, is

labeled RADAR ALTM and has two positions marked CHAN 1 and CHAN 2. Placing the switch in either position will allow the RT unit in the respective channel to transmit and receive.

RADAR ALTIMETER BYPASS SWITCH.

The radar altimeter bypass switch (4, figure 1-60), located on the miscellaneous switch panel, is a two position switch marked NORMAL and BYPASS. Placing the switch to BYPASS when above 5000 feet over the terrain provides a signal to the TFR to permit blind letdowns. The switch will go to NORMAL as 5000 feet is passed during descent. When the switch is in the NORMAL position, blind letdowns from below 5000 feet above terrain may be accomplished. After T.O. 1F-111-996, positioning the switch to BYPASS when performing TF operations below 5000 feet AGL will cause a TF fail and a fly-up maneuver. This will also cause the radar altitude low warning lamp to light unless actual AGL is within ± 10 percent of the 1875 foot pseudo radar altitude from the bypass switch.

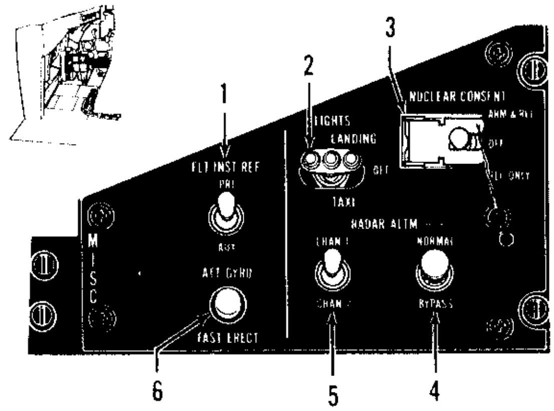
RADAR ALTIMETER.

The radar altimeter (20, figure 1-6), located on the left main instrument panel, provides absolute altitude indications from 0 to 5000 feet. Indications are provided by a pointer on a dial graduated in increments of 10 feet from 0 to 500, 50 feet from 500 to 1000, and 500 feet from 1000 to 5000. An OFF warning flag in a window on the right side of the dial will appear when power is removed from the system, when the system malfunctions or when roll or pitch limits are exceeded.

WARNING

If power is lost on the system, the OFF warning flag will appear on the dial and the pointer will remain at the last powered indication.

Miscellaneous Switch Panel



1. Flight Instrument Reference Select Switch.
2. Landing and Taxi Lights Switch.
3. Nuclear Consent Switch.
4. Radar Altimeter Bypass Switch.
5. Radar Altimeter Channel Selector Switch.
6. AFRS Gyro Fast Erect Button.

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Figure 1-60.

The radar altimeter control knob on the lower right of the altimeter serves three functions; as an on-off control, to set a minimum altitude index pointer on the dial and as a test button to check the system. Initially turning the knob clockwise applies power to the system; further rotation of the knob rotates the index pointer from zero to any desired minimum altitude setting. Depressing and holding the knob activates the self-test feature of the system and, if the RT unit is operating properly, provides an indication of 95 (± 12) feet before T.O. 1F-111-996; 300 (± 15) feet after T.O. 1F-111-996.

The self-test feature may be used at any time and at any altitude below 38,000 (±5000) feet.

WARNING

After T.O. 1F-111-996, initiation of the self-test during TF operations at the 200- and 300-foot set clearances while the radar altimeter signal to the TFR is controlling the aircraft may result in a dive command from the TFR. In this case, the 83 percent fly-up will not be operable.

RADAR ALTITUDE LOW WARNING LAMP.

The radar altitude low warning lamp (21, figure 1-6), located on the left main instrument panel, will light when the absolute altitude of the aircraft is at or below the minimum altitude set into the radar altimeter. When lighted, the letters RADAR ALT LOW are displayed on the face of the lamp in red.

Note

- Prior to T.O. 1F-111-996, performing a self-test of the radar altimeter while flying TFR will cause a fly-up, since the false altitude the altimeter locks on during self-test is less than 83 percent of any selected clearance.
- After T.O. 1F-111-996, performing a self-test of the radar altimeter during terrain following at set clearances of 400 feet or above will cause a fly-up, since the false altitude (300 ± 15 feet) that the radar altimeter locks on during self-test is less than 83 percent of these clearances. If the radar altimeter signals are controlling the aircraft and self-test is performed at 200- or 300-foot set clearances, a dive may result. The 83 percent fly-up will be inhibited during radar altimeter self test at the 200- and 300-foot set clearances.

After T.O. 1F-111-996, this lamp is also used in conjunction with the low altitude monitor. The monitor will cause this lamp to light for any of the following conditions:

1. The radar altitude data to the radar altimeter differs from that being supplied to the TFR by 10 percent or more.
2. The aircraft has penetrated below 83 percent of selected set clearance.
3. The value of set clearance has failed to zero feet.
4. The low altitude monitor has failed.

When the warning lamp lights due to any of these conditions, a fail fly-up maneuver will occur. A fail fly-up will not occur if the lamp lights due to indicated radar altitude being less than that set by the index pointer.

LOW ALTITUDE MONITOR.

On aircraft modified by T.O. 1F-111-996, the low altitude monitor provides a redundant 83 percent fly-up function to back up the 83 percent fly-up circuitry in the TFR. If, during terrain following operations, the aircraft descends below 83 percent of the selected clearance for any reason, the low altitude monitor will (1) cause the radar altitude low warning lamp to light (if it is not already lighted as a result of the aircraft being below the minimum altitude set into the radar altimeter), and (2) interrupt the TF data good signal to the flight control system, which will cause initiation of a fly-up maneuver. In addition, the low altitude monitor compares the two altitude signal outputs from the selected radar altimeter channel. If these signals differ by more than 10 percent, the radar altitude low warning lamp will light and a fly-up maneuver will be initiated. The purpose of this comparator is to detect a failure in the radar altimeter altitude signal to a high limit, or a failure of the bypass switch to properly switch from BYPASS to NORMAL. The low altitude monitor also contains an internal monitor to detect a malfunction in the selected clearance circuitry. If a malfunction is detected, this monitor will cause the radar altitude low warning lamp to light and a fly-up maneuver to be initiated. The monitoring functions of the low altitude monitor are enabled only when one or both TFR channels are in TF mode and the radar altimeter is locked-on.

Note

If the radar altitude low warning lamp lights because of a failure sensed by the low altitude monitor, the lamp will not go out when the autopilot release lever (before T.O. 1F-111(B)A-593) or autopilot release/pitch control stick steering lever (after T.O. 1F-111(B)A-593) is depressed.

TERRAIN FOLLOWING RADAR (AN/APQ-134).

The terrain following radar (TFR) provides low altitude terrain following, obstacle avoidance and blind letdown capability. The TFR consists of left and right antenna receivers, synchronizer transmitters, power supplies and computers in a dual channel configuration; a radar scope panel and a control panel. Each channel may be operated independently of the other in any one of three modes; terrain following (TF), situation display (SIT), or ground mapping (GM). During Auto or Manual TF turning flight maneuvers, the TFR antenna is positioned to look along the anticipated flight path and the climb/dive commands are compensated for the aircraft being in a roll attitude. The TFR receives inputs from the radar altimeter, attack radar, converter set, flight controls system, doppler radar, central air data computer. Refer to figure 1-62 for TFR system tie-ins with other weapon system avionic equipment. The TFR operates on 115 volt ac power from the main ac bus and 28 volt dc power from the main dc bus.

Auto TF Flight Control Schematic (Typical)

NOTE:
ATF MODE SHOWN ENGAGED. WHEN FLYUP OCCURS, CLIMB/DIVE COMMANDS FROM THE TFR SET ARE IGNORED & FLIGHT CONTROL SWITCHES TO A SEPARATE, INTERNALLY GENERATED FLY UP SCHEDULE.

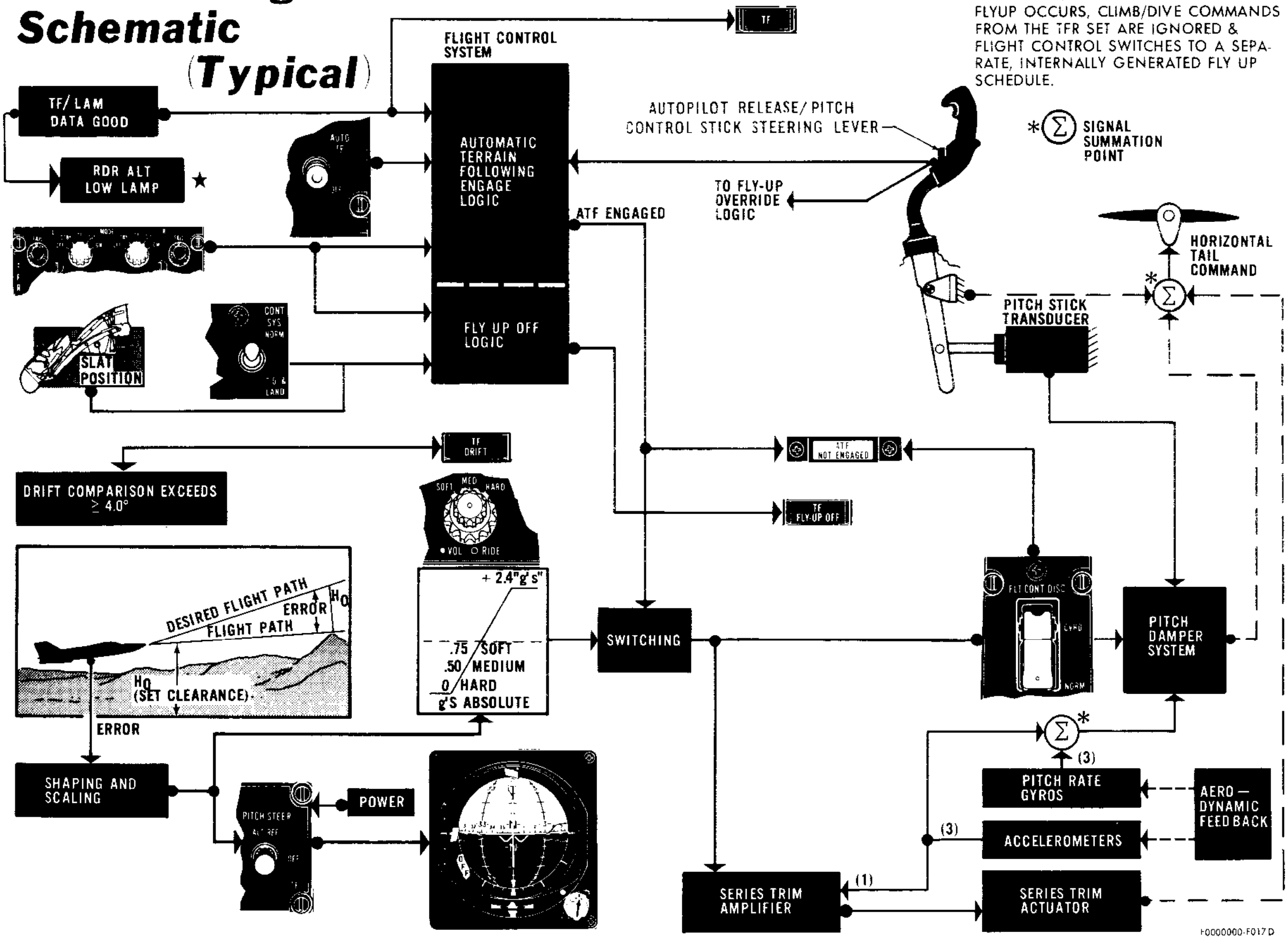

Figure 1-61.

Terrain Following Radar Subsystem Tie-Ins

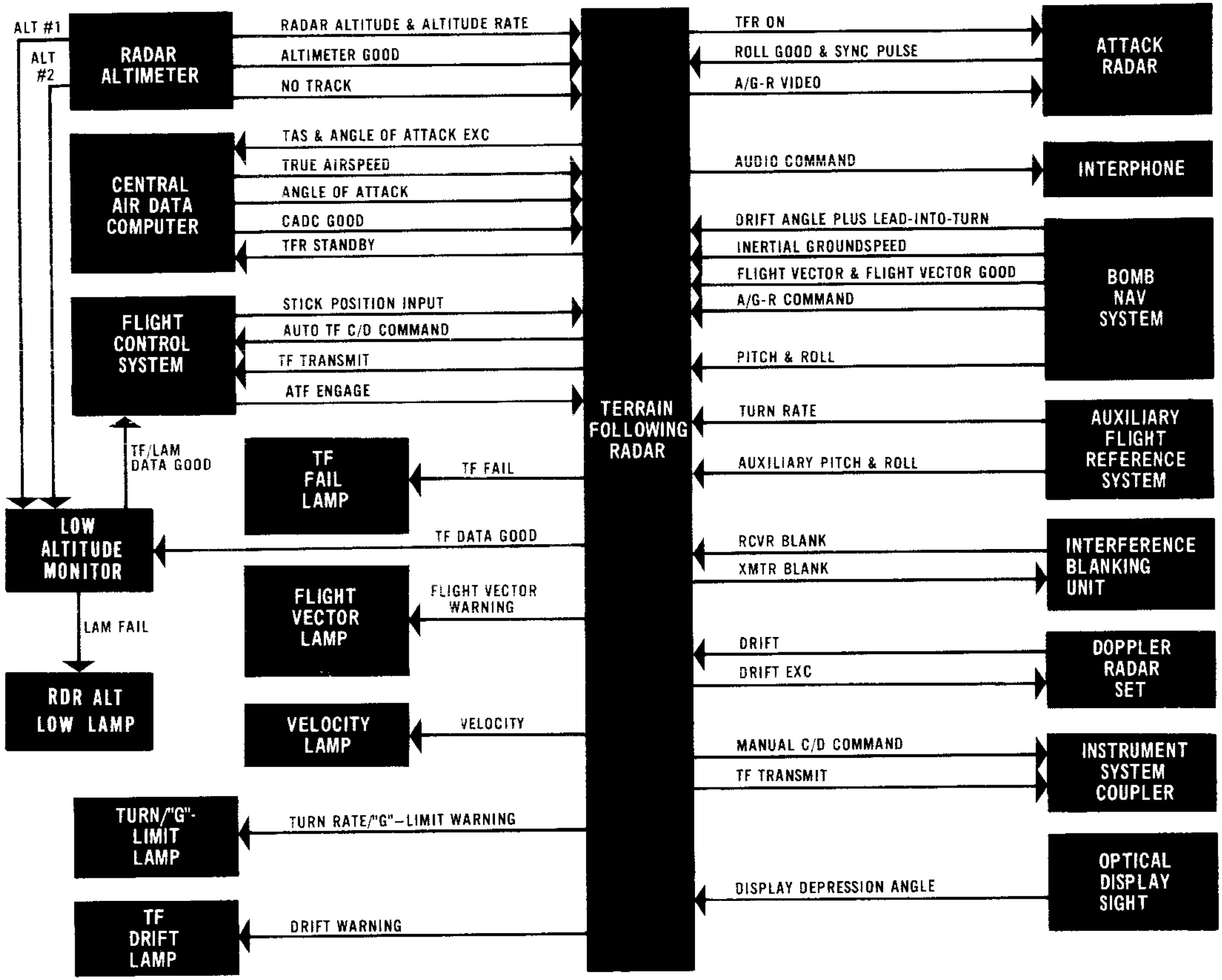

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Figure 1-62.

TERRAIN FOLLOWING (TF) MODE.

The TF mode allows the aircraft to be flown manually or automatically at a preselected terrain clearance. Climb and dive signals generated in this mode can be furnished to the attitude director indicator (ADI), optical display sight (ODS) and to the flight control system. The set terrain clearance can be manually maintained by flying pitch steering commands on the ADI and ODS. In auto TF operation the set terrain clearance will be automatically held. Should the aircraft descend to below 83 percent of the selected terrain clearance altitude setting, or if the aircraft is banked more than 45 degrees, the ADI and ODS will indicate a fly-up command and a flyup maneuver will be initiated, if the aircraft is being flown with the auto TF switch in either the AUTO TF or OFF positions. After T.O. 1F-111-996, a failure detected by the low altitude monitor will light the radar altitude low warning lamp and cause the flight control system to initiate a fly-up maneuver. However, the TF failure warning lamp and pitch steering bars may not indicate a fail condition.

Note

> The initial aircraft response to the fly-up command may be as much as +2.8 absolute "g's."

The TF mode can also be used to make blind letdowns to a preselected terrain clearance. When using this capability, descent can be made manually using the pitch steering commands on the ADI and ODS, or automatically by placing the auto TF switch to the AUTO TF position. The descent is limited to a 12 degree dive. Only one channel at a time can be operated in TF mode. If both channels are placed to TF the second channel placed to TF will go to a standby condition as a backup and will automatically take over should the operating channel fail. A failure in the operating TFR channel will cause a fly-up command to be sent to the pitch damper with the auto TF switch in either AUTO TF or OFF and a fly-up steering command will be displayed on the ADI and ODS pitch steering bars.

Note

> The fly-up command can be interrupted by holding the autopilot release lever depressed (autopilot release/pitch control stick steering lever to the first detent after T.O. 1F-111(B)A-593). To get rid of the fly-up signal the TFR channel controlling the aircraft must be turned out of the TF mode. If the auto TF switch is in the AUTO TF position it should be positioned to OFF. The fly-up signal is locked out to prevent automatic fly-up when the flight control system is in the take-off and land configuration.

Refer to figure 1-61 for information pertaining to tie-in of the TFR with the flight control system.

In the TF mode, antenna scan is vertical and the scope display is in the form of a non-linear E type presentation. A zero command line, displayed on the scope, provides a terrain clearance reference. The slope of the zero command line will vary with the speed of the aircraft, terrain clearance setting and the type of ride selected. Range displays on the scope are from left to right on a nonlinear scale so that ranges up to two miles are displayed over three-fourths of the scope and the remaining one-fourth of the scope displays returns up to ten miles. Elevation of returns along the ground track are displayed vertically on the scope.

Note

> Electromagnetic interference from HF radio transmission on some frequencies may cause a fly-up maneuver when operating the TFR in the TF mode. This interference may also cause degradation of the TFR scope displays. If HF radio use is essential and interference is noted when operating in the TF mode, the terrain should be cleared visually or, if this is not possible, the aircraft climbed to the minimum enroute altitude.

SITUATION (SIT) MODE.

This mode of operation is used in conjunction with TF mode for obstacle avoidance. Antenna scan is in azimuth, 30 degrees either side of ground track. Antenna tilt cannot be adjusted. Returns of the terrain that are at or above the aircraft altitude are displayed on the radar scope in a one radius offset PPI presentation. Ground track is stabilized vertically along the center of the scope. Range graduations in this mode are linear.

GROUND MAPPING (GM) MODE.

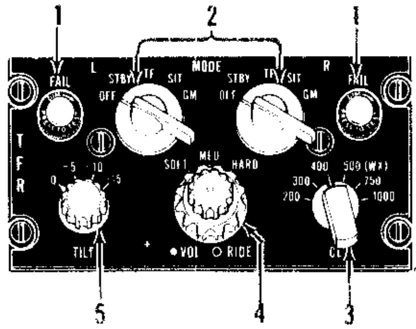
The GM mode provides a scope presentation of the terrain that is ahead of the aircraft. Antenna tilt can be adjusted for best picture. This mode is used primarily for navigation. The antenna scan and the type of scope display are the same as when operating in SIT mode.

TFR CONTROL AND INDICATORS.

TFR Channel Mode Selector Knobs.

Two, five position rotary channel mode selector knobs, (2, figure 1-63), located on the TFR control panel, permit selection of the desired operating mode in each of the two channels. The knobs are labeled L and R for the respective channel and are individually marked OFF, STBY, TF, SIT and GM. In the OFF position, power is removed from the channel. In the STBY position, power is applied to the channel for warmup. The TF, SIT and GM positions provide terrain following, situation display or ground mapping modes of

TFR Control Panel (Typical)



1. TFR Channel Failure Caution Lamps (2).
2. TFR Channel Mode Selector Knobs (2).
3. Terrain Clearance Knob.
4. Ride/Volume Control Knob.
5. Antenna Tilt Control Knob.

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Figure 1-63.

operation respectively. Each channel may be operated in a different mode; however, unless one channel is in TF mode the reference not engaged lamp will light when AUTO TF is selected. If both knobs are positioned to TF the second channel will automatically go to a standby condition, then, should the operating channel fail the one in standby will automatically take over. The channel that failed can be checked by rotating the mode selector knob from TF to STBY and back to TF again. The channel fail lamp will go out, but is not an indication that the malfunction has cleared until the operating channel selector knob is rotated out of TF causing the first channel to take over in the TF mode. If the channel fail caution lamp does not light the malfunction has cleared and the channel is operating properly. When channel switching occurs over water, it is normal for the second channel to initially fly the aircraft above the set clearance with a gradual decrease in the command until the set clearance is re-established. This condition is caused by the standby channel having a full climb present from the altimeter override command which receives zero altitude while in standby.

CAUTION

If both channels are not placed in STBY or above when operating the TFR or attack radar, the crystal diodes in the receiver of the channel in OFF may be ruined, thus rendering the receiver inoperative.

Auto Terrain Following Switch.

The auto terrain following (auto TF) switch (3, figure 1-26), located on the autopilot/damper panel, is a two position lever lock switch marked AUTO TF and OFF. The switch is locked in the OFF position and must be pulled out to move from OFF to AUTO TF. When the switch is in the OFF position and either TFR channel mode selector knob is in the TF position, the aircraft must be flown manually using the pitch steering commands on the ADI and ODS to hold the terrain clearance selected on the TFR terrain clearance knob. With the switch in the OFF position the reference not engaged lamp will remain on. When the switch is placed to the AUTO TF position and either TFR channel mode selector knob is in the TF position signals from the TFR will control the pitch damper to automatically hold the aircraft on the terrain clearance setting selected by the TFR terrain clearance knob. With the switch in AUTO TF the reference not engaged caution lamp (ATF not engaged caution lamp after T.O. 1F-111(B)A-593) will go out.

Note

When auto TF is selected at least one TFR channel must be in the TF mode or the fly-up off caution lamp and the reference not engaged caution lamp (ATF not engaged caution lamp after T.O. 1F-111(B)A-593) will light.

Prior to T.O. 1F-111(B)A-593, when the AUTO TF position is selected and the autopilot release lever is not held, the control stick will be centered. After T.O. 1F-111(B)A-593, when the AUTO TF position is selected and the autopilot release/pitch control stick steering lever is not held to the first detent, the control stick will be centered. If auto TF mode is controlling the aircraft, as indicated by the reference not engaged caution lamp (ATF not engaged caution lamp after T.O. 1F-111(B)A-593), the pitch trim function of the stick trim button will be inoperative.

Terrain Clearance Knob.

The terrain clearance knob (3, figure 1-63), located on the TFR control panel, has six positions marked 200, 300, 400, 500, 750 and 1000. Rotating the knob clockwise increases the altitude clearance setting corresponding to the position selected and vice versa. The 500 position provides a weather mode marked (WX)

which limits the area from which radar returns are processed.

WARNING

When the 500 foot position is selected, the TFR does not command on targets beyond 15,000 feet or above the aircraft fuselage center line, and will not anticipate the terrain early enough to provide a command to prevent terrain impact if airspeed limits are exceeded. Refer to Section V for airspeed limitations for this clearance setting.

Note

When flying at one clearance setting and the knob is positioned to a higher setting, a TF failure and fly-up may be generated until the aircraft is maneuvered outside the 83 percent radar altimeter fly-up range.

The TFR should maintain flight within the following tolerances. If these tolerances are not maintained the equipment should be written-up after the flight. If an under-shoot occurs to the extent that an 83 percent fly-up occurs, change to the other channel. If the fly-up again occurs select the next higher setting. Do not operate at the lower setting where the 83 percent fly-up occurred.

Selected Clearance	Terrain Clearance Min.	Terrain Clearance Max.
200	170	300
300	260	425
400	350	550
500	440	650
750	675	950
1000	900	1200

During automatic terrain following flight over level to rolling terrain or over water with HARD ride selected, the radar altimeter should indicate the altitude above the terrain corresponding to each clearance knob setting within these tolerances. Terrain clearances when cresting peaks will usually be slightly less than the stabilized, level terrain clearances. The above tolerances are not directly applicable to terrain following flight over rugged terrain; however, terrain clearances when cresting peaks should not consistently be below these tolerances.

Ride/Volume Control Knob.

The ride/volume control knob (1, figure 1-63), is a dual purpose coaxial type and is located on the TFR control panel. The inner knob labeled RIDE is a three position rotary knob marked SOFT, MED, and HARD. This knob controls the magnitude of the negative "g" forces imposed on the aircraft by the flight control system as it maintains a set altitude clearance above the terrain. The commanded dive "g" forces of 0.3, 0.5 and 0.75 will be experienced in the HARD, MED, and SOFT positions respectively. The system will automatically provide a pull up command if necessary to avoid an obstacle regardless of the ride selected. The outer knob labeled VOL adjusts the volume of aural commands heard through the interphone. The aural commands consist of 2500 Hz frequency tone for climb and 500 Hz frequency tone for dive at 20 pulses per second per "g." Any time the pitch steering bars on the ADI and ODS are centered there will be no tone.

Note

- When not using TFR the knob should be turned as required to prevent interference on interphone.
- After T.O. 1F-111-1074, during TFR operation secondary volume control of the TFR aural is provided by the ILS monitor knob on each communications panel.
- The aural climb/dive command will correspond to the ADI/ODS pitch commands during normal TF operation, however, during a fail condition the aural tone will not necessarily be a climb command and should be disregarded.

Antenna Tilt Control Knob.

The antenna tilt control knob (5, figure 1-63), located on the TFR control panel is used to position antenna tilt between zero and −15 degrees for the best ground return when operating in the GM mode. The knob will continuously vary the antenna position between zero and −15 degrees. The knob has antenna tilt angles of 0, −5, −10 and −15 marked for reference only.

Range Selector Knob.

The range selector knob (5, figure 1-64), located on the TFR scope panel, has four positions marked 5, 10, 15 and E. The first three positions change range of the scope presentation when using SIT or GM modes. The E position is used with the TF mode only.

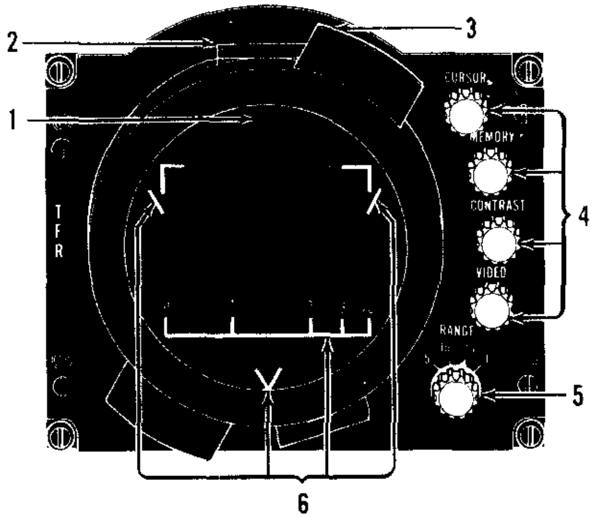
Radar Scope Tuning Control Knobs.

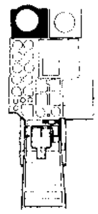
Four radar scope tuning control knobs (4, figure 1-64), located on the TFR scope panel, provide a means of adjusting the scope to obtain the best display. The knobs are labeled CURSOR, MEMORY, CONTRAST and VIDEO from top to bottom. The cursor knob adjusts the brilliance of the range cursors. The memory knob increases or decreases scope storage retention time. The contrast knob adjusts scope contrast for optimum viewing. The video control adjusts the video return brightness to desired level.

Radar Scope.

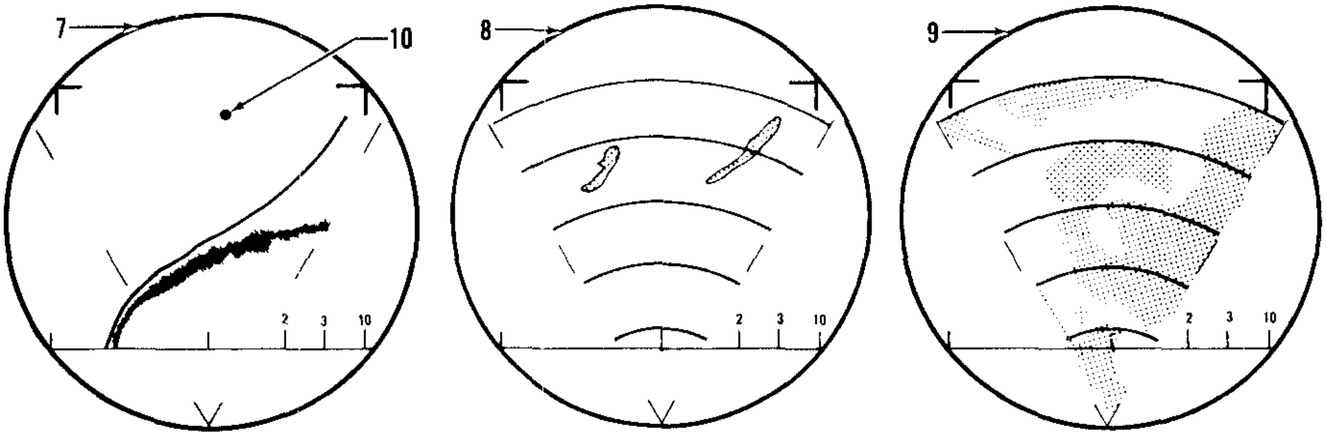
The radar scope (1, figure 1-64), located on the TFR scope panel, provides a direct viewing presentation of either an E (vertical scan) display when in TF mode

TFR Scope Panel and Presentations

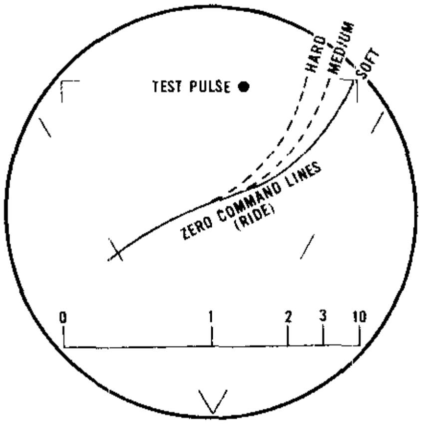




1. Radar Scope.
2. Polaroid Filter Control (2).
3. Scope Removal Handle (2).
4. Radar Scope Tuning Control Knobs (4).
5. *Range Selector Knob.*
6. Scope Overlay.
7. TF Mode Terrain Following E Display.
8. Sit Mode Lateral Terrain Search PPI Display.
9. GM Mode Ground Mapping PPI Display.
10. Test Pulse.



Test Patterns



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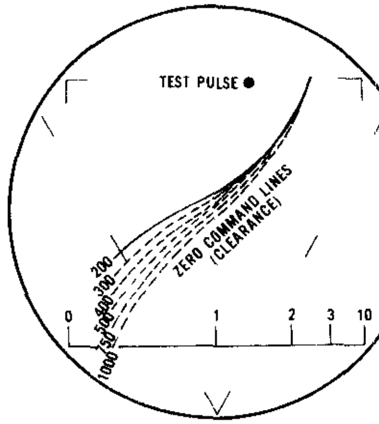

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Figure 1-64.

or a sector PPI (azimuth scan) display when operating in SIT or GM modes. The scope overlays provide a rectangular grid with a 0 to 10 nautical mile scale at the bottom of the scope for TF mode and a "V" shaped grid for sector PPI presentations in SIT or GM modes. A self-test pulse (10, figure 1-64) is located at approximately 1.5 miles range at the top of the E scope presentation when the system is in TF mode of operation. Absence of this pulse, in TF mode, indicates improper system operation. The polaroid filter controls around the face of the scope can be rotated to adjust polarization of light for the best display under various degrees of light. A red scope presentation for night vision adaptation can be obtained with the filter controls. The ear type handles on each side of the scope are provided to facilitate removal or installation of the unit.

Note

When in visual bomb with DIV selected, the attack radar and TFR, when in GM or SIT modes, are used for air-to-ground ranging. Under this condition the attack radar and TFR ground mapping or situation scope presentation will be unusable and should be ignored. If one channel is in TF mode, the E scope presentation will be normal.

TFR Channel Fail Caution Lamps.

Two amber channel failure caution lamps (1, figure 1-63), located on the TFR control panel, are individually marked FAIL and are labeled L and R for the respective left and right channels. When the channel mode selector knob is placed from OFF to STBY the fail lamp will light to indicate that channel is not yet ready to operate. The lamp will go out after approximately 3 minutes indicating the channel is ready. After the channel is ready, a fail light with the mode selector switch in TF, SIT or GM position, indicates a malfunction in that channel. The lamps will also light when the aircraft is above 5000 feet absolute altitude and the radar altimeter bypass switch is in the NORMAL position. A press-to-test feature allows each lamp to be checked.

Note

- The lamps will momentarily blink when changing the TFR terrain clearance knob from low to higher clearance settings or switching into or out of the 500(WX) setting. This is a normal indication.
- The lamps will also blink rapidly when more than 0.5 "g"s are commanded if the instrument system coupler pitch steering mode switch is not in the TF position when operating in the manual TF mode.

TF Drift Caution Lamp.

The TF drift caution lamp located on the main caution lamp panel (figure 1-29) provides an indication that the primary and secondary drift plus lead into turn signals do not compare within 4 degrees. When this occurs the TFR antennas are locked at zero degrees azimuth and therefore can no longer lead the aircraft into turns. When the lamp is lighted the letters TF DRIFT are visible. Under IFR conditions TF flight should not be performed unless drift and turn rate are zero when the lamp is lighted. Under VFR conditions fly TF in slow turns or with small drift angles only if the terrain clearance can be verified.

WARNING

When the drift caution lamp is lighted, TF flight should not be performed with drift angles in excess of 3 degrees, and bank angles should be limited to 10 degrees unless terrain clearance can be assured under VFR conditions.

Reference Not Engaged Caution Lamp.

The reference not engaged caution lamp is located on the left main instrument panel (figure 1-29). The following conditions must be satisfied to put the reference not engaged caution lamp out during TFR operation:

1. Either TFR channel selector knob in the TF position
2. The auto TF switch in the auto TF position and
3. "G" command controlling the aircraft with the TFR checking safe.

While operating in auto TF the lamp can come on due to conditions not associated with TFR operations. For example, if operating in auto TF with either constant track or heading navigate autopilot, lateral control stick steering will disengage the autopilot heading sub-mode and cause the lamp to light. With the lamp lighted under this situation, a subsequent failure in the "g" command logic will go undetected and could result in the aircraft flying into the ground. For detailed description of the lamp and its function with other systems, refer to Autopilot System, this section.

WARNING

When the reference not engaged caution lamp lights while in auto TF immediate action must be taken to put the lamp out or terminate auto TF flight to prevent possible terrain impact.

Flight Vector Caution Lamp.

The flight vector caution lamp located on the main caution lamp panel (figure 1-29) provides an indication that the TFR is no longer making a comparison check of the aircraft flight vector and that the TFR may be computing using the backup flight vector. The lamp will light when either the inertial flight vector data good signal or the CADC data good signal is lost to the TFR. If the CADC data good signal is not received at the TFR, the lamp will light and the primary flight vector will be used in the TFR computation. If the inertial flight vector data good signal is not received at the TFR, the lamp will light and backup flight vector (aircraft pitch angle minus aircraft angle-of-attack) will be used in the TFR computation. The letters FLT VECTOR are visible on the lamp when it is lighted.

Turn Rate/G-Limit Caution Lamp.

The turn rate "g"-limit caution lamp located on the main caution lamp panel (figure 1-29) provides an indication when lighted that any or all of the following conditions exist:

1. The aircraft is executing a turn in which the heading rate exceeds the maximum safe value (2.0 degrees per second) for which the TFR antenna lead-into-turn stabilization is reliable.

Note

If excessive roll rates or rapid reversal of bank are accomplished the turn rate/g limit caution lamp may not light immediately due to the lag in the turn rate caution circuitry.

2. The aircraft is in a roll attitude and the computed roll compensated climb command exceeds 2.47 "g"s.
3. The caution lamp will light whenever the aircraft is at a zero roll and close enough to an obstacle that the TFR is generating its maximum 2.47 "g" command.

Note

The TFR is limited to commanding a maximum of 2.47 "g" maneuvers.

The lamp should be monitored in turns. When the lamp lights the bank angle should be reduced to put the lamp out. When lighted, the letters TURN/G-LIMIT are visible on the lamp.

Velocity Caution Lamp.

The velocity caution lamp located on the main caution lamp panel (figure 1-29) indicates the TFR is computing with a mach 0.8 airspeed. The lamp will light when the true airspeed and DCC ground speed differ by 130 knots. The letters VELOCITY are visible on the lamp when it is lighted. Terrain following flight shall be restricted to a velocity range of 0.7 mach to 0.9 mach when the lamp is lighted. Should the comparison return to its normal level the lamp will go out and operation will be normal.

WARNING

Airspeed should be held between mach 0.7 and 0.9 when the velocity caution lamp is on. If these speeds are exceeded the TFR will not properly anticipate terrain clearance commands and the aircraft may fly into the ground.

Note

After T.O. 1F-111(B)A-651, the velocity caution lamp will light during TFR ground checks.

TF Fly-up Off Caution Lamp.

The TF fly-up off caution lamp, located on the main caution lamp panel (figure 1-29) provides an indication that fly-up protection is not available. The letters TF FLY-UP OFF are visible on the face of the lamp when it is lighted. The fly-up maneuver is inhibited until the fly-up circuit is armed. The fly-up off lamp will be lighted during TF mode selection until the fly-up circuit is armed. Arming of the fly-up circuit will result in the TF fly-up off lamp going out. The fly-up circuit can be armed by one of two ways (a) The TF set must initially check safe (TF fail warning lamp goes out) or (b) Prior to T.O. 1F-111(B)A-593, the autopilot release lever momentarily depressed; after T.O. 1F-111(B)A-593, the autopilot release/pitch control stick steering lever momentarily depressed to the first detent. After the fly-up circuit is armed, a subsequent TF fail signal (TF fail warning lamp comes on) will result in a fly-up maneuver. The fly-up circuitry is interlocked with the flight control system switch and slat extension mechanism to prevent inadvertent fly-ups during takeoff and landing operations. When airborne and with the L or R TFR channel mode selector knob in the TF position, the lamp will light when the flight control system switch is: (1) in the T.O. & LAND position, or (2) in the NORM position and the slats are extended. Certain power failures within the TFR system will also cause the lamp to light. The lamp will also light if the auto TF switch is placed to the AUTO TF position and neither TFR channel is in a TF mode, however this is an abnormal switching configuration and should be avoided. Terrain following flight should not be attempted when the lamp is lighted.

TF Failure Warning Lamp.

A TF failure warning lamp (15, figure 1-6), located on the left main instrument panel, provides a more

apparent indication of TFR channel malfunctions. If each channel is being operated in a different mode the lamp will light when the channel in TF mode malfunctions. If both channels are in TF mode, the lamp will momentarily light when the channel in operation fails and the backup channel takes over. Should the backup channel in turn fail, the lamp will light and remain on.

OPERATIONAL CONSIDERATIONS.

Terrain Following Mission Planning.

The aircraft is equipped with a terrain following radar (TFR) system that when properly used will give the aircraft a contour following flight path which will afford the maximum in surprise and terrain concealment. However, to gain the most benefit from the TFR, careful pre-flight planning must be accomplished to assure safe low level operation. The following steps should be used as a guide in preparing for a mission involving TFR operation.

(1) Determine aircraft configuration and required radius of action.

(2) Maximum airspeed for the configuration to be flown should be determined from Section V. This limit should be converted to KIAS limit for the highest terrain to be over flown.

(3) Maximum gross weight to be used on TFR should be determined from Section V. Enter the appropriate load chart with 2.8 "g" (maximum initial fly-up command) to determine the maximum gross weight.

(4) Determine the initial maximum allowable angle-of-attack and corresponding minimum airspeed for the desired wing sweep from the Maximum Angle of Attack and Minimum Airspeed for TF Operation Chart in Appendix I. With this or higher airspeed, calculate cruise performance for the desired radius of action to assure an adequate fuel reserve. The minimum allowable airspeed provides a speed margin of approximately 20 KIAS to allow for minor speed changes due to the difficulty of holding a precise angle-of-attack (airspeed) during TF operation. The maximum allowable angle-of-attack shown in the referenced chart is provided for the purpose of defining the minimum airspeed at which a TF failure (fly-up maneuver) may be experienced without exceeding the angle-of-attack limits presented in Section V. Maintaining an angle-of-attack in excess of that shown in the referenced chart may result in exceeding those limits in the event of a fly-up.

(5) Next, carefully select the route for TFR operation. When possible, select a course parallel to ridge lines and along valleys in an attempt to keep terrain features between your aircraft and detection devices or ground to air weapons as long as practical. The route should be planned to avoid sand dunes and man made obstacles such as TV or radio towers, high power lines between valleys, smoke stacks and water towers.

(6) After the route has been tentatively selected to take advantage of terrain features for surprise and concealment, a close study should be made to determine the highest terrain feature above the stabilized flight altitude. The 'delta' altitude is important in preflight planning for three reasons: (1) It will determine whether you will need military or afterburner power to go over the obstacle. (2) It will enable you to plan the type of pull up maneuver if the TFR should fail approaching the obstacle. (3) It might require a new route selection if the afterburners must be used to clear the obstacle and cruise performance or night visual detection are critical to mission accomplishment. The TFR mission profile planning data in Appendix I will enable you to determine the delta altitude that can be cleared.

(7) With the actual route established and outlined on a map, a minimum enroute altitude (MEA) should be determined and indicated along the route. This MEA should provide at least 1000 feet above all obstacles five miles either side of the route. The TFR mission profile planning data in Appendix I should be consulted to assure that the aircraft can attain this MEA in 6NM at military power. If afterburner power is necessary, a route change might be in order should night visual detection or cruise range be a consideration.

(8) Route turning points need special consideration during TFR operation because of the limitations of the TFR system during turns. TF flight can be performed up to 15 degrees of roll angle or 2 degrees per second of turn rate. In a turn, the turn/"g" limit caution lamp should be closely monitored. The lamp will come on when the aircraft exceeds 2 degrees per second turn rate or when the TFR computed command is greater than 2.1"g's". If this caution lamp comes on, reduce the turn rate or roll angle until it goes out. If it does not go out, go to the MEA. In the event of a TF fail in a bank, go to zero bank when terrain permits.

(9) The TFR mode of operation should be determined primarily as follows: (1) For day VFR conditions, one channel in TF and one channel in SIT with frequent monitoring of the E-scope. (2) For night and IFR conditions, one channel in TF and one channel in SIT. The E-scope display should be selected and monitored with crosschecks to SIT display as desired.

Note

In IFR conditions, the E-scope should be monitored for weather returns so as to anticipate a fly-up command as a result of weather.

(10) The terrain clearance setting will normally be determined by the following considerations: (1) VFR or night and IFR conditions. (2) Terrain profile and differential altitude. (3) Height of trees or man-made obstacles. (4) Mission requirements, i.e. training or combat.

(11) The desired TFR ride quality, i.e., soft, medium, and hard, determines how closely the flight path follows the desired clearance over the contour of the terrain. Medium ride is recommended for most TFR flight conditions especially during turbulence, night or IFR operation. Hard ride can be safely used; however, pushovers of 0.3 to zero "g" can be expected over rough terrain. These pushovers can be disconcerting and loose articles and dirt in the cockpit can cause serious distraction.

(12) The aural command is a valuable aid and should be used in IFR conditions.

Operating Configurations.

The recommended operating configuration for the TFR is to use one channel in the TF mode and the other channel in the SIT mode for maximum utilization of the terrain following and obstacle avoidance capabilities of the system. It is specifically recommended that the automatic channel switchover feature (both channel mode selector knobs in TF) not be used at clearances below 500 feet. Should a failure occur at the lower clearances in the channel operating in the TF mode, a clearance of 1000 feet should be flown after manually switching to TF in the opposite channel until proper performance is confirmed. It is also recommended that the index pointer in the radar altimeter be set to 83 percent of the clearance to be flown. If the low altitude warning lamp lights and a fly-up maneuver has not been initiated, immediately take control of the aircraft and recheck the 83 percent fly-up circuitry at a safe clearance on both TFR and altimeter channels before resuming TF flight. When flying auto or manual TF the radar altimeter indicator must be monitored for an altitude error, especially while flying over terrain having low radar return. The altitude information from the radar altimeter is used to generate the TF climb/dive command when forward video is lost. If there is an error on the radar altimeter indicator, e.g., indicating approximately 3000 feet while flying level at less than 1000 feet, and forward video is lost the climb/dive command will be a dive and the 83 percent fly-up will not occur because the altitude being in error indicates a condition of being above selected set clearance.

WARNING

- Terrain following flight should not be attempted when there is an obvious altitude error indicated on the radar altimeter indicator.
- Both crew members must monitor aircraft terrain clearance during TF flight. During periods when forward video is lost (due to water or low surface reflectivity) aircraft altitude will be monitored by using outside visual reference (if possible), AVVI interpretation, and close observation of TF system operation. The crew should be especially watchful for unexplained descents while over water or level terrain.

Changing Terrain Clearance Settings.

When changing selected clearances on the TFR to a higher setting, the terrain clearance control knob should be progressively rotated through each intermediate setting and the aircraft allowed to stabilize at the intermediate clearances until the desired clearance is reached. Instantaneous switching beyond more than one incremental clearance may cause the aircraft to assume a climb angle greater than 20 degrees, thus possibly causing the radar altimeter to lose range track. In this event, the aircraft will not level out at the desired clearance setting and the fly-up must be overridden by manual control.

Blind Let-Down.

When initiating a blind let-down in the TF mode from above 5000 feet absolute, the radar altimeter will not be locked and will drop out its data good signal to the TFR. To prevent this signal from generating a fly-up, the altimeter by-pass switch must be positioned to BY-PASS to give the TFR a pseudo altitude and data good signal. Upon passing through 5000 feet the altimeter should lock and the by-pass switch will drop out and normal altitude and data good signals will be supplied to the TFR. If the terrain is mountainous, the clearance may suddenly increase beyond 5000 feet and a fail signal will result. Should this occur immediately reposition the by-pass switch to BY-PASS and resume the let-down. If the let-down is being made to 1000 feet set clearance, the dive angle will be limited to 10 degrees until the radar altimeter locks. At this time the dive angle may increase to 12 degrees. At other set clearances the dive limits are 12 degrees above and below 5000 feet. It is recommended that an initial set clearance of 1000 feet be used for all blind letdowns. At this clearance setting, a climb command should be indicated on the ADI/ODS command bars at approximately 2000 feet AGL and aircraft rotation toward level flight should begin no later than 1600 feet AGL. When a let-down is made from high altitude in the vicinity of mountainous or rugged terrain the following is recommended to minimize the annoying radar altimeter break-lock when passing through the lock-on altitude and also to reduce the rate of descent at the set clearance level-off. Manual descent to MEA is recom-

mended with the autopilot release lever depressed, while the aircrew monitors the pitch steering bar and E scope display. After the aircraft is established at MEA and the attack radar and E scope reveal no abrupt ridges along the aircraft flight path, an auto TF descent should then be initiated. Aircrews should be aware that while flying at MEA, the 5000 foot limit of the radar altimeter may be exceeded resulting in a TF fail-safe fly-up.

WARNING

- When a blind let-down is made, the radar altimeter must be monitored to assure that it locks on after passing through 5000 ft absolute. If the let-down is made over water or areas of low radar energy return, the radar altimeter is the only source of a signal to compute a level-off at the set clearance.
- Letdowns started below 5000 feet absolute do not verify proper radar altimeter operation.

Low Altitude Fly-Up Recovery.

The fly-up command generated by descending below 83 percent of the set clearance will be terminated when the aircraft climbs to the 83 percent point. When an 83 percent fly-up occurs, the autopilot release lever should be depressed (autopilot release/pitch control stick steering lever to the first detent after T.O. 1F-111(B)A-593), the auto TF switch should be positioned to OFF and the aircraft manually flown until it is determined that it is safe to resume TFR operation.

WARNING

If the condition that caused the aircraft to initially descend below 83 percent is still present and the TFR is allowed to control the aircraft, a pushover can result which will dive the aircraft back through the 83 percent point at an angle from which a fly-up command cannot recover.

Overriding Fly-Up Maneuvers.

Should a TF fail or, after T.O. 1F-111-996, a low altitude monitor fail occur and a fail-safe fly-up maneuver be initiated, the maneuver should be overridden by depressing the autopilot release lever (autopilot release/pitch control stick steering lever to the first detent after T.O. 1F-111(B)A-593) on the control stick. The TF failure warning lamp will remain on when the lever is depressed. Before releasing the autopilot release lever, the pilot should check that the channel failure caution lamp on the TFR control panel for the channel in the TF mode is not lighted and, after T.O. 1F-111-996, that the radar altitude low warning lamp is not lighted. If the channel failure caution lamp is still on, releasing the autopilot release lever will allow the fly-up maneuver to be resumed. Should the fly-up maneuver not be terminated by depressing the autopilot release lever (autopilot release/pitch control stick steering lever to the first detent after T.O. 1F-111(B)A-593), the TFR should immediately be switched out of the TF mode, the auto TF switch turned to OFF, and the fly-up overridden by stick force if necessary. The pitch trim function of the stick trim button is disabled and the control stick is centered during TFR fly-up maneuvers.

Aircraft Pitch Attitude.

If the pitch attitude of the aircraft exceeds 20 degrees of pitch during a fly-up command, the radar altimeter may break track. If this occurs, the fly-up must be manually overridden until the radar altimeter can regain track and allow the TFR to check safe.

Turning During TF Flight.

TF flight can be performed up to 45 degrees of roll angle or 2 degrees per second of turn rate. If the roll limit is exceeded, the TFR will declare a fail and fly-up command. During turns in AUTO TF operation, the pitch steering bar will indicate a slight climb command. If the turn rate limit is exceeded the turn/"g"-limit caution lamp will come on. The TFR antennas lead the aircraft in a turn but cannot scan terrain which might be in the aircraft path in turns greater than 2 degrees per second. In a turn, the turn/"g"-limit caution lamp should be closely monitored. If this caution lamp comes on, reduce the turn rate or roll angle until it goes out. In the event of a TF fail in a roll, go to zero roll when terrain permits.

WARNING

If the turn/"g"-limit caution lamp comes on during a turn, reduce the turn rate or roll angle until it goes out. If a TF fail occurs in a roll, go to zero roll when terrain permits.

Stick Pitch Inputs During Auto TF.

If in the process of making small heading corrections during auto TF, some stick force is applied in pitch, the aircraft response to auto TF commands may be degraded up to 5 seconds after the stick control forces are released. During TF fail safe fly-ups, control of the aircraft should be achieved by depressing the autopilot

release lever (autopilot release/pitch control stick steering lever to the first detent after T.O. 1F-111(B)A-593) and using stick force until a decision is reached regarding continued TF operation. Angle-of-attack should not be allowed to exceed operating limits included in Section V. Maintain safe terrain clearance during this period.

Aircraft Trim.

When the auto TF switch is placed to the AUTO TF position, and the autopilot release lever is not held, the control stick will be centered. When the auto TF mode is controlling the aircraft the pitch trim function of the stick trim button is inoperative.

WARNING

Do not use auxiliary pitch trim while operating in auto TF mode. To do so will result in degraded auto TF performance such as ballooning over hills.

Auxiliary pitch trim should not be used during auto TF operation. If nose up trim is used the series trim actuator will drive nose down until the trim effect is neutralized. This reduces the amount of remaining down elevator available through the series trim actuator. When a down command is subsequently received from the TFR, there will be insufficient elevator remaining to keep the aircraft on the set clearance and ballooning on the back side of hills will occur.

Tower Detection Capabilities.

Towers and power lines may not reflect sufficient returns to cause the TFR to fly the aircraft over the obstacles. Flights should be planned to avoid these areas.

Effect of Precipitation.

Preflight planning must include consideration of enroute weather. If heavy rain or thunderstorm activity is forecast, TFR operation may not be possible. Use of attack radar to vector around weather cells is recommended and the 500(WX) set clearance will provide more capability in dense clouds or rainfall. The E scope should be monitored for video returns from weather during TFR flight. The back scatter from moderate to heavy precipitation will often be visible on the E scope. If the operator cannot determine where the terrain ends and the precipitation begins on the E scope, the automatic signal detection circuitry will also be incapable of discrimination and a climb command will result. As video returns from rain approach the zero command line from the right side of the E scope, a climb command can be expected. When a climb command occurs, the pilot should not allow the auto TF to exceed the angle-of-attack limits or exceed a 20 degree climb attitude and should add power to maintain airspeed. If either of these angle limits are encountered, depress the autopilot release lever, maintain the climb, and level off at a safe altitude (not less than MEA). When the video from weather disappears from the E scope and normal ground return is present, TFR operation can be resumed.

WARNING

- Certain weather conditions can cause blanking (no video presentation) of the E scope and/or attack radar with no associated fly-up. This blanking eliminates radar returns from terrain and precipitation. The TFR system interprets the blanking as the ground return from a flat, low radar energy return surface such as a body of water and reverts to radar altimeter override mode. In this mode, the TFR will not provide safe flight over other than known level terrain.
- If E scope blanking due to weather conditions is observed or suspected, an immediate climb must be initiated to MEA.

The improved weather penetration capabilities of the planar array antennas were achieved as a trade-off against degraded detection capabilities of smooth, regular objects (i.e., towers, water tanks, etc.). Flights should be planned to exclude these targets from the flight path.

Flight Over Wooded Terrain.

During flight over sparsely wooded terrain, dead or defoliated trees, the TFR may not command sufficiently on the back scatter from the trees to maintain the selected clearance over the tops of the trees thus the tops of isolated trees may project above the 83 percent fly-up threshold at the lowest clearance. To avoid unsafe flight conditions a minimum clearance of 200 feet greater than the tops of the trees should be used during TF flight over areas of dead trees or extremely tall trees. Over densely wooded areas, the radar altimeter will tend to measure aircraft clearance alternately between the ground and the tops of the trees, thus the indicated radar altitude may become very erratic and may generate a number of short duration fly-ups.

Flight Over Sloping Terrain.

When flying over smooth sloping areas of low reflectivity such that radar altimeter commands are controlling the aircraft, the aircraft will fly at an offset from the selected clearance proportional to the mag-

nitude of the slope. If the flight path is up an extended slope, the aircraft will fly below set clearance by 87 feet/degree of slope and the 83 percent fly-up threshold may be reached. When flying down an extended slope, the aircraft will fly at an offset above the set clearance.

Flight Over Mountainous Terrain.

When flying auto TF over steep mountainous terrain, a fly-up command without a failure indication may occur shortly after cresting a peak which has a large extended slope with a small hill on the back side. This fly-up is an inherent characteristic of the terrain following radar system and the frequency and severity is a function of the terrain, set clearance, airspeed, ride setting and aircraft gross weight. Fly-ups for a duration of up to 4 seconds may be experienced with angle-of-attack approaching 15 degrees with buffet onset. Fly-ups of this nature can be minimized, if desired, by performing flight over rough mountainous terrain at a higher set clearance and/or selection of medium or soft ride.

Use of E-Scope.

The E-scope presentation is intended for an advisory display and is not a primary command display. The pilot can fly manual TF by keeping the video below the command line but due to the lack of proper feedback to the display it should not be used as the primary manual display command below 500 feet set clearance; however, the E-scope display should be monitored at all clearances to determine if forward video returns are being received. When the video on the TFR scope becomes weak or barely visible, the commands will be generated from the radar altimeter. Under these conditions the pilot must assure that the surface is water or other low reflectivity smooth surface by visual means or by comparison with the other TFR channel.

Note

> At clearance settings of 750 feet, the start of the TFR zero command line (ZCL) may have a short vertical line extending downward. Terrain video may penetrate through the vertical portion when flying close to the selected clearance. Also, below 750 feet clearance, there may be a short gap in the ZCL near the center of the presentation that can change with ride control, selected clearance or airspeed. These are normal conditions on the E-Scope presentation and will not affect system performance.

SIT Mode Display.

The SIT mode of the TFR provides a scope display of targets that are at or above the aircraft altitude. Since this mode does not provide a margin of vertical clearance, the scope display should only be used as a reference for avoiding obstacles and not for overflying obstacles.

Primary Attitude Reference.

The TFR is dependent upon the bomb nav system for roll, pitch, flight vector, drift and turn signals. The AFRS provides backup pitch and roll signals. Since all sources of possible error are not continuously tested, the flight crew should monitor all available cockpit indications (such as cross-checking primary vs. auxiliary attitude indicators, large differences between heading and ground track, unrealistic winds, radar scope stabilization etc.) to detect any malfunctions that may not be detected by the bomb-nav system. If an abnormal condition is observed, TF flight should be terminated.

Auxiliary Attitude Reference.

The auxiliary flight reference system (AFRS) provides pitch and roll signals to the TFR as the primary source when the inertial navigation system is inoperative or not selected. During terrain following flight on the AFRS, primary attitude reference will not be available for a comparative check to detect errors or failures on critical inputs to the TFR system. When using the auxiliary reference the primary attitude, heading, and flight vector caution lamps will be lighted indicating that the primary flight vector is not being used.

WARNING

> Terrain following flights should be limited to day VFR conditions when the AFRS is furnishing attitude signals to the aircraft subsystems.

Fuel Low Caution Lamp Indications.

During operation over mountainous terrain with hard ride selected, the negative g's encountered during pushover maneuvers may cause the fuel low caution lamp to light. Prolonged pushovers could result in engine flameout due to fuel starvation.

WARNING

> If the fuel low caution lamp remains lighted when flying TF over terrain which generates zero "g" pushovers the ride control knob should be positioned to MED or SOFT. Failure to do so could result in engine flameout.

Aiming Reticle & Steering Bar Presentations (Typ)

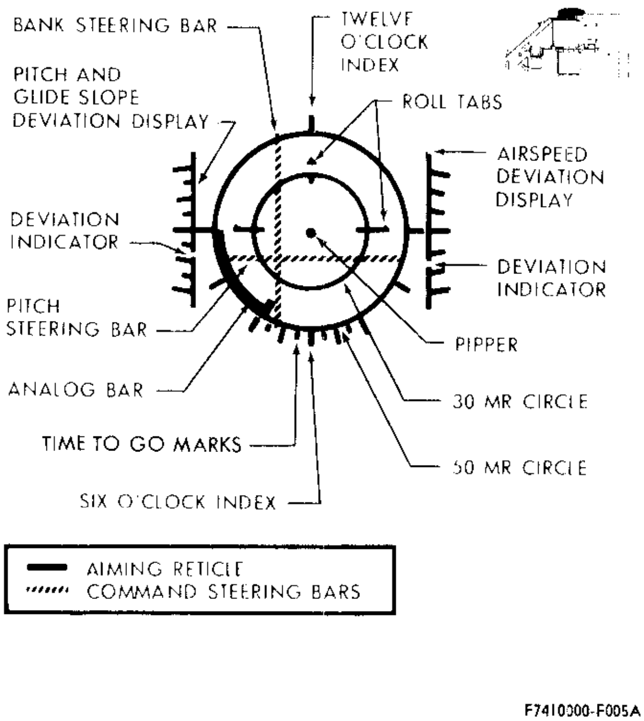


Figure 1-65.

OPTICAL DISPLAY SIGHT (AN/ASG-25) (ODS).

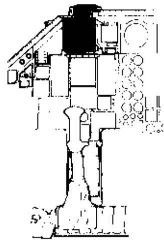
The optical display sight (ODS) is integrated with other systems in the aircraft to deliver bombs and missiles, and provide homing, navigation and landing information. The system consists of the optical display sight and control panel, located at the left crew station, and an amplifier located in the forward electronics bay. The optical display sight provides indications in the form of two presentations: an aiming reticle, lighted in red, and a set of command steering bars, lighted in green. Refer to figure 1-65 for aiming reticle and command steering bar presentations. The aiming reticle consists of a 2 milliradian center pipper, a 30 milliradian circle, roll reference tabs, a 50 milliradian circle, analog bar reference tabs which serve as a time-to-go scale, an analog bar presentation, and two deviation indicators. All elements of the aiming reticle are fixed with respect to one another as the aiming reticle display moves about on the combining glass. The analog bar represents time-to-go prior to weapon release or pull-up and appears as a bar of light on the lower half of the 50 milliradian circle. The 50 milliradian circle has fixed indices located at the 3, 4, 5, 6, 7, 8 and 9 o'clock positions, each index denoting 100 seconds when in the 300 second scale, or 10 seconds when in the 30 second scale. The three movable indices of the reticle display are the roll tabs. The roll tabs provide an indication of the roll attitude of the aircraft. Roll tab reference indices are located at 9, 12, and 3 o'clock positions on the 30 milliradian circle. Deviation indicators to the left and right of the reticle rings provide indications of aircraft attitude and speed deviations from preset conditions. The left deviation indicator provides pitch or glide slope deviation indications, depending on the mode selected with the instrument systems coupler mode select knob. When operating in the ILS or AILA mode, the left deviation indicator presents deviation from the glide slope. Full scale represents a glide slope deviation of 0.7 degrees. When operating in any mode other than ILS or AILA, the left deviation indicator presents the pitch deviation from the pitch preset value set into the ODS. Full scale represents a pitch deviation of 10 degrees. The right deviation indicator provides airspeed deviation indications from a preset indicated airspeed value. Each graduation mark represents 10 knots, and a full scale deviation is 30 knots. When the bomb/nav system is operating in the autonomous mode, the airspeed deviation indications are not reliable. The command steering bars consist of a pitch steering bar and a bank steering bar superimposed over the aiming reticle. The center pipper of the aiming reticle is the zero reference for the steering bars. When the bars are centered, part of the bars are blanked out to provide a window around the pipper. The steering bars function independently of the ODS mode select knob, and provide duplicate indications of the ADI steering bars. Large right azimuth deviations without a corresponding right roll maneuver may cause the bank command bar to drive out of view to the right. Large down pitch steering deviations without a down pitch rate may cause the pitch command bar to drive out of view at the bottom of the sight reticle. Mechanical stops prevent the bars from driving out of view to the left or to the top of the sight reticle. For detailed explanation of the ODS command steering bar indications, refer to "Instruments" this section. The ODS functions in six primary modes of operation. The system utilizes 28 volt dc power from the main dc bus, and 115 volt, three phase 400 cycle ac power from the left main ac bus.

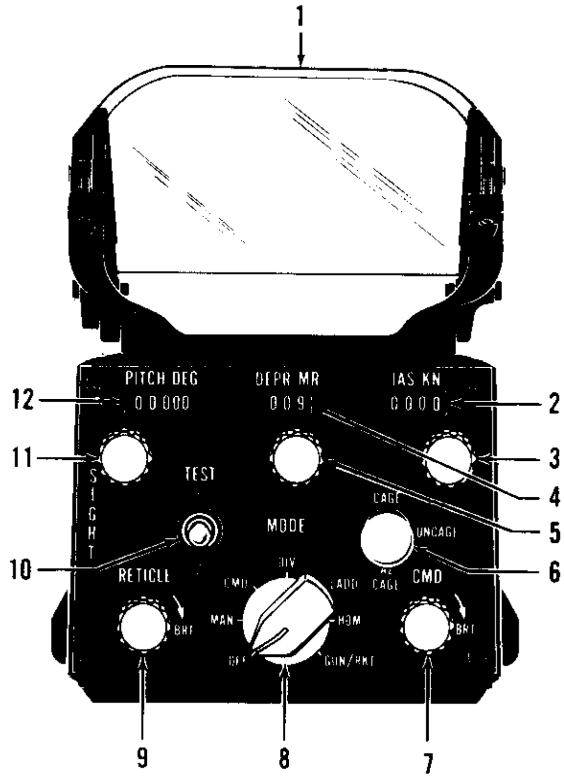
ODS MODE SELECT KNOB.

The ODS mode select knob (8, figure 1-66) has 7 positions marked OFF, MAN (manual), CMD (command), DIV (dive), LADD (low angle drogue delivery), HOM (homing), and GUN/RKT (gun/rockets). In the OFF position all functions of the ODS are inoperative. Refer to figure 1-67 for ODS indications in the various knob positions. Each knob position provides the following indications and functions:

- The MAN (manual) position is used when the pilot desires manual control of the reticle.

Optical Display Sight Control Panel





1. Optical Sight.
2. Preset Indicated Airspeed Indicator.
3. Indicated Airspeed Set Knob.
4. Reticle Depression Indicator.
5. Reticle Depression Set Knob.
6. Aiming Reticle Cage Lever.
7. Command Bar Brightness Knob.
8. Mode Select Knob.
9. Aiming Reticle Brightness Knob.
10. Test Switch.
11. Pitch Degree Set Knob.
12. Pitch Degree Indicator.

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Figure 1-66.

- The CMD (command) position is utilized in the ILS or AILA modes and with other systems in four sub modes to provide indications used for radar or visual bombing or combinations of both, updating the bomb-nav system digital computer complex (DCC), and air refueling tanker rendezvous. For bombing, the ODS is utilized with the attack radar in one of the ground modes, the bomb nav system in either radar bomb or visual bomb mode and with the instrument system coupler in bomb nav mode. Indicated airspeed and pitch angle are preselected and set on the ODS control panel. The attack radar can be utilized to locate the target and provide steering bar indications on the ODS to steer the aircraft toward the target. If visual conditions exist, the ODS pipper can also be used to line up on the target. If a radar run is made the ODS analog bar will provide time-to-go indications to bombs away and the weapon will be released automatically on a release signal generated by the bomb nav system on inputs from the attack radar. If a visual run is made the pilot will fly the aircraft so that the target will drive down the reticle toward the pipper. When the target is superimposed under the pipper a manual release can be made utilizing either weapon release button. When used to update the bomb nav system the ODS is utilized to make a visual run on a fixpoint similar to making a bomb run except when the fixpoint is under the pipper the enter visual fix (EVF) button is depressed to enter the updated information in the bomb nav system. For air refueling rendezvous the ODS is used in conjunction with the attack radar in the air mode and the instrument system coupler in the tanker rendezvous (TKR RV) mode to provide steering bar indications on the ODS to steer the aircraft to the tanker.

Note

In this configuration the bank steering bars on the ODS and ADI will oscillate after the attack radar locks-on the target. This is normal and is due to the automatic angle tracking of the radar. The amplitude of the oscillation will increase as the range is decreased, however the frequency of the oscillation will remain constant.

- The DIV (dive) position is used in conjunction with the bomb nav system in the visual bomb mode to deliver bombs in diving attacks. Preselected values of airspeed and pitch angle are set on the ODS con-

ODS Mode Select Knob Positions Versus Indications

Mode Select Knob Positions		*Bomb Nav Function Select Knob*	*Fix Mode Selector Knob*	*Instrument System Coupler Mode Sel. Knob*	*Aiming Reticle AZ.*	*Aiming Reticle EL.*	*Analog Bar*	*Roll Tabs*	*Airspeed*	*Pitch or Glide Slope*	*Command Bars*	*Signal Flag*
OFF												
MAN. (Manual Mode)		Any	Any	Any	Cage	Man. Dep.	Stow	Available in all modes	Indicated airspeed deviation from manual set in all modes	Pitch angle from manual set, unless landing mode signal is present then glide slope deviation	Available in all modes to display steering commands	
CMD (Command Mode)	Radar Bombing (Sub-mode)	Bomb Radar	Optional	Bomb Nav	CCIP	Fixed Angle	Tg Rel					
	Visual Bombing (Sub-mode)	Visual Bomb	Optional	Optional	Positioned to CCIP solution		Stow					
	Updating the DCC (Sub-mode)	Not Bomb	Visual Auto	Any	Positioned to Drift Angle	to Fix Angle	Stow					
	Air Refueling (Sub-mode)	Not Bomb	Not Visual Auto	Tanker Rendezvous	Cage	Man. Dep.	Stow					
DIV (Dive Mode)		Visual Bomb	Optional	Optional	Positioned to a CCIP solution		Tg Pullup					At Pull-up
		Radar Bomb	Any	Any	CCIP	Fixed Angle	Stow					
		Not Bomb			Cage	Man. Dep.						
LADD (Low Angle Drogue Delivery)		Not Radar Bomb	Any	Any	Drift	Man. Dep.	Tg Pullup then Tg Rel.					Rel Un-safe (Nuc)
		Bomb Radar			Cage		Stow					
HOM (Homing Mode)		Any	Any	Any	RHAW	RHAW	Stow					
GUN/RKT		Not Used										

Figure 1-67.

trol panel and the aircraft is maneuvered into the dive to the target. The bomb nav system provides continuously computed impact point information to the ODS during the dive. Anytime the pipper can be positioned on the target the weapon may be released manually with either weapon release button. The analog bar will display time-to-go to the pull-up point. Pull-up must be started prior to the analog bar reaching the six o'clock position to safely complete the maneuver.

- The LADD (low angle drogue delivery) position is used for delivering bombs on a target using the low angle drogue delivery maneuver. Bombing computations are entered in the bomb nav system when the weapon selection is made on the stores control panel. As the aircraft approaches the target a pull-up signal is generated by the bomb nav system and the pull-up lamp on the left main instrument panel will light. The pilot will initiate a pull-up maneuver to zero the pitch steering bar. The bomb nav system will generate a release signal at the proper point in the maneuver for weapons release. The analog bar will display time-to-go. When the bar reaches the 6 o'clock position, the bomb nav system will generate a release signal, the release lamp on the left main instrument panel will light and the weapon will be released.
- The HOM (homing) position is used to aid in visual detection of ground radar targets. The radar homing and warning system (RHAW) will generate signals representative of the angular position of the ground radar. The signals are used by the ODS to position the reticle over the ground radar within the field of view of the ODS sight and the pilot can visually search for the ground radar in the vicinity of the reticle pipper.
- The GUN/RKT (gun/rocket). The aircraft does not have the capability of carrying guns and rockets. Information for this mode will be furnished if the aircraft is equipped with this capability.

PITCH DEGREE (PITCH DEG) SET KNOB.

The pitch degree set knob (11, figure 1-66), located on the optical display sight control panel, is used to set in the desired pitch angle. A pitch degree indicator (12, figure 1-66), located directly above the knob will display the pitch in degrees set in by the knob.

RETICLE DEPRESSION (DEPR MR) SET KNOB.

The reticle depression set knob (5, figure 1-66), located on the optical display sight control panel, is used to set in desired depression angles of the aiming reticle. A reticle depression indicator (4, figure 1-66), located directly above the set knob, indicates in milliradians the reticle depression set by the depression set knob.

INDICATED AIRSPEED (IAS KN) SET KNOB.

An indicated airspeed set knob (3, figure 1-66), located on the optical display sight control panel, is used to set in a desired indicated airspeed. A preset indicated airspeed indicator (2, figure 1-66), located directly above the set knob, indicates the indicated airspeed in knots set in by the indicated airspeed set knob.

TEST SWITCH.

The test switch (10, figure 1-66), located on the optical display sight control panel, is provided to allow an operational check and a fault isolation check to be performed on the ODS while installed in the aircraft without the aid of test equipment. The switch has positions 1 and 2 and is spring-loaded to the center OFF position. Position 1 is used for performing in-flight and ground self tests. Position 2 is used for performing ground fault isolation tests only.

AIMING RETICLE CAGE LEVER.

The aiming reticle cage lever (6, figure 1-66), located on the optical display sight and control panel, has three positions labelled CAGE, UNCAGE, and AZ CAGE. In the CAGE position the aiming reticle is mechanically caged to 3 degrees below the fuselage reference line and 0 degrees in azimuth. In the UNCAGE position, the aiming reticle is free to move in azimuth and in elevation. In the AZ CAGE position, the aiming reticle is mechanically caged to 0 degrees in azimuth.

AIMING RETICLE BRIGHTNESS KNOB.

The aiming reticle brightness knob (9, figure 1-66), located on the optical display sight and control panel, is provided to adjust the brilliance of the aiming reticle. Rotating the knob full clockwise will provide full brilliancy and may create a double image. Rotating the knob full counterclockwise will turn off the aiming reticle.

COMMAND (CMD) BAR BRIGHTNESS KNOB.

The command bar brightness knob (7, figure 1-66), located on the optical display sight and control panel, is provided to adjust brilliance of the command steering bars. Rotating the knob full clockwise will provide full brilliancy. Rotating the knob full counterclockwise will turn off the command steering bars.

PENETRATION AIDS.

Refer to classified supplement T.O. 1F-111(B)A-1-3 for information pertaining to Penetration Aids.

LIGHTING SYSTEM.

The lighting system is divided into external and internal lights.

EXTERIOR LIGHTING.

The exterior lights include position lights, formation lights, anti-collision/fuselage lights, air refueling lights, landing lights and a taxi light. The position lights consist of green lights in the right glove and wing tip, red lights in the left glove and wing tip and a white tail light. The wing tip position lights will light when the wing sweep angle is between 16 and 30 degrees. When the wings are swept aft of 30 degrees the wing tip light will go out and the glove light will light. The reverse will occur as the wings are swept forward. The formation lights consist of a set of two lights, located on the upper and lower surfaces of each wing tip, and four lights located forward and aft of each side of the fuselage. The lights in the wing tips correspond to the color of the left and right position lights. The fuselage lights are amber. Two anti-collision/fuselage lights, one located on top and one located on the bottom of the fuselage, serve as white fuselage lights when retracted and flashing red anti-collision lights when extended. Two air refueling lights mounted in the air refueling receptacle are provided for night refueling operations. A limit switch on the air refueling receptacle door provides power to the receptacle light control knob when the door is open. Two landing lights and a taxi light are located on the nose landing gear. A switch on the nose gear down lock will turn the lights off if they are on when the gear is retracted.

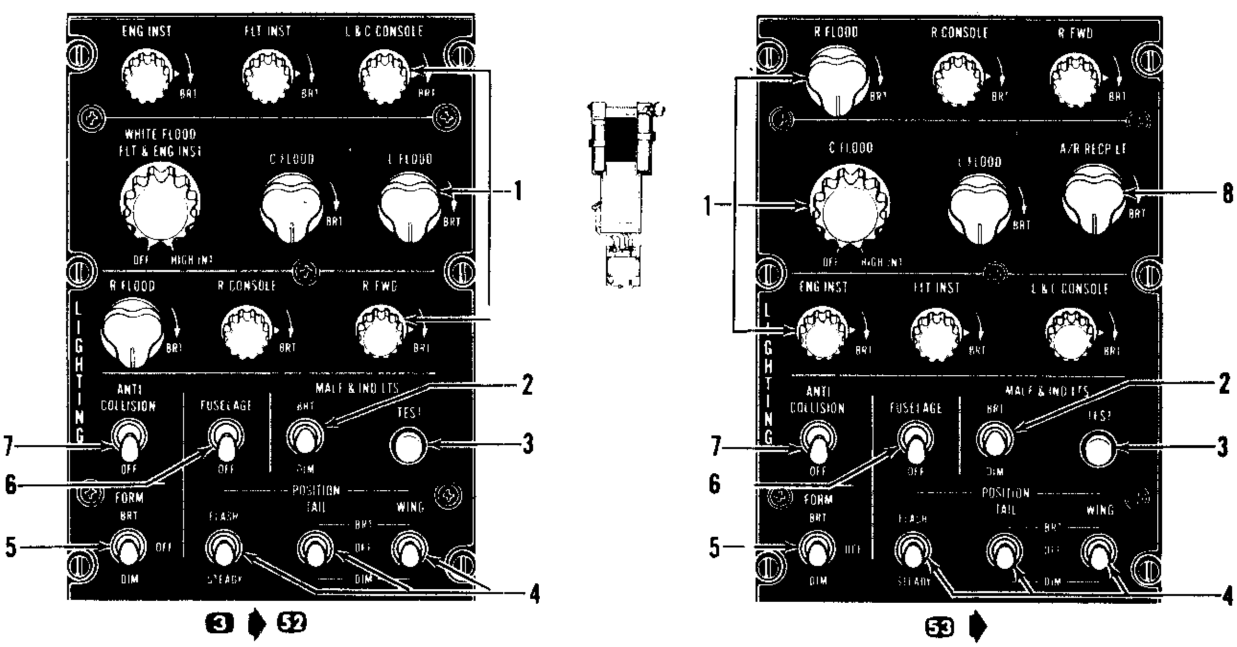
Position Light Switches.

Three position light switches (4, figure 1-68), are located on the lighting control panel. Two switches, labeled WING and TAIL, have three positions, marked BRT (bright), OFF and DIM, for selecting the desired intensity of the position lights. The third switch is a two position switch marked FLASH and STEADY to control the operation of the position lights. Placing the switch to FLASH causes the position lights to flash at a rate of 80 cycles per minute.

Position Lights/Stores Refuel Battery Power Switch.

The position lights/stores refuel battery power switch (5, figure 1-27), located on the ground check panel, has three positions marked POS LIGHTS, NORM and STORES REFUEL. Placing the switch to the POS LIGHTS position will supply battery power to the position lights for added safety during ground handling. Placing the switch to NORM connects these circuits to the essential dc bus. The switch is held in the

Lighting Control Panel (Typical)



1. Internal Lighting Control Knobs.
2. Malfunction and Indicator Lamp Dimming Switch.
3. Malfunction and Indicator Lamp Test Button.
4. Position Lights Switches.
5. Formation Lights Switch.
6. Fuselage Lights Switch.
7. Anti-Collision Lights Switch.
8. Air Refueling Receptacle Lights Control Knob.

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Figure 1-68.

NORM position when the ground check panel door is closed. For a description of the STORES REFUEL position of the switch refer to the Fuel Supply System, this section.

Formation Lights Switch.

The formation lights switch (5, figure 1-68), located on the lighting control panel, provides selection of the desired intensity of the lights. The switch is marked BRT (bright), OFF and DIM and controls 115 volt ac power from the right main ac bus.

Anti-Collision Lights Switch.

The anti-collision lights switch (7, figure 1-68), is located on the lighting control panel. The switch is labeled ANTI-COLLISION and has one position marked OFF and an unmarked ON position. Placing the switch to ON causes the anti-collision lights to light, extend and rotate. Placing the switch to OFF causes the lights to retract, go out and stop rotating. The switch controls 115 volt ac power from the left main ac bus.

Fuselage Lights Switch.

The fuselage lights switch (6, figure 1-68), is located on the lighting control panel. The switch is labeled FUSELAGE and has a position marked OFF and an unmarked ON position. Placing the switch to ON, lights a white light in the top and bottom of the fuselage.

Air Refueling Receptacle Lights Control Knob.

On aircraft 3 ➧ 52, the air refueling receptacle lights control knob is located on the left main instrument panel (35, figure 1-6). On aircraft 53 ➧, the knob is located on the lighting control panel (8, figure 1-68). Regardless of the location the knob is labeled A/R RECP LT. The full counterclockwise position of the knob turns the lights off. As the knob is turned clockwise the intensity of the lights varies from off to full brightness. The knob controls 115 volt ac power from the essential ac bus.

Landing and Taxi Lights Switch.

The landing and taxi lights switch (2, figure 1-60) is located on the miscellaneous switch panel. The switch is marked LANDING, OFF and TAXI. The switch controls 28 volt dc power from the essential bus which in turn controls relays to provide 115 volt ac power to a transformer which in turn provides 28 volt ac power to the filaments in the lights. If the switch is left in either the LANDING or TAXI positions on takeoff a switch on the nose gear down lock will turn them off when the landing gear is retracted.

INTERNAL LIGHTING.

The internal lights include instrument panel and console lights, red and white flood lights and utility lights. The instrument panel and console lights consist of five circuits, each with an individual control knob, for the flight instruments, engine instruments, left and center console, right console and right main instrument panel. They are powered by 115 volt ac power from the right main ac bus. The flood lights consist of left, center and right red flood lights and high intensity white flood lights at various locations around the cockpit. The red flood lights provide cockpit lighting in the event the instrument panel and console lights fail. Each set of red flood lights has an individual control knob. The white flood lights provide high intensity lighting to prevent temporary blindness from lightning when flying in weather. One control knob adjusts the intensity of all the white flood lights. Both the red and white flood lights receive 115 volt ac power from the ac essential bus. Two utility lights (50, figure 1-2 and 19, figure 1-31), one for each side of the cockpit, are provided for individual work lights. They are normally stowed on the left side of the aft console and on the right side of the right instrument panel but can be moved to various locations about the crew station. A slight rotation of the lamp will lock it in place on its mount. The front of each utility light can be rotated to change color from white to red and vice versa. A rheostat on the aft end of each light must be turned clockwise to turn the light on and set the desired intensity. The utility lights are powered by 28 volt dc from the engine start bus. Aircraft 53 ➧ are equipped with white instrument and flood lights only.

Internal Lighting Control Knobs.

The internal lighting control knobs (1, figure 1-68), located on the lighting control panel, control the various internal lighting circuits. The full counterclockwise position of each knob turns the lights off. As the knobs are turned clockwise, detent positions at spaced intervals vary the intensity of the lights from off to full brightness. Five of the knobs control the instrument panel and console lighting. Knobs are labeled and control the respective circuits as follows:

FLT INST—Left main instrument panel.

ENG INST—Engine instruments.

L&C CONSOLE—Left and center consoles.

R CONSOLE—Right console.

R FWD—Right main instrument panel.

The flood lights are controlled by individual knobs marked R FLOOD, C FLOOD and L FLOOD for the right, center and left flood lights respectively. On aircraft 3 ➧ 52, the knob marked WHITE FLOOD FLT & ENG INST controls all the white flood lights. On aircraft 53 ➧, the knob marked C FLOOD con-

trols these white flood lights. In both cases this knob is marked OFF at the full counterclockwise position and HIGH INT (high intensity) near the full clockwise position. Turning the knob past HIGH INT turns all the white flood lights to maximum intensity. This will also turn on additional white flood lights. Once these lights are on, their intensity may be decreased by turning the knob counterclockwise. All of the white flood lights will be turned off when the knob is rotated to the OFF position.

CANOPY.

The canopy consists of left and right clam shell hatches hinged to a center beam assembly. The hatches open to a maximum of 65 degrees. Each hatch has an external and internal canopy latch handle for opening or closing. When the hatches are closed and latched, the internal handle locks in place to prevent inadvertent unlatching of the hatch inflight. Each hatch is manually raised or lowered with the aid of an air/oil counterpoise. The counterpoise will also hold the hatch in any position selected. A flush mounted plunger, located adjacent to the external handle, can be pushed in to unlock the internal handle from the outside.

INTERNAL CANOPY LATCH HANDLES.

Two canopy latch handles are located on the inside lower horizontal frame member of each canopy hatch (7, figure 1-2). An over-center spring-loaded canopy latch handle lock tab, in the face of each canopy latch handle, locks the handle in the latched position to prevent inadvertent opening inflight. When the lock tab is flush the canopy latch handle is locked. Pressing in on the forward part of the lock tab will cause the rear part of the tab to snap out, unlocking the canopy latch handle. The handle must then be pulled out and aft to a detent position to unlatch the hatch. Once the hatch is unlatched, pulling the handle further aft past the detent engages the counterpoise to aid in opening. When the desired hatch position is attained, the handle must be returned to the detent position to lock the counterpoise and hold the hatch. Each handle is mechanically linked to a flush external canopy latch handle located outside of each hatch. Inflation of the canopy pressurization seal is automatically operated by closure of the canopy hatch. The actuator mounted on the hatch lower surface depresses a plunger in the canopy sill to inflate the seals and turn off the canopy unlock warning lamp.

CANOPY EXTERNAL LATCH HANDLES.

Two flush mounted canopy external latch handles are located on the lower horizontal frame member of each canopy hatch. Each handle is mechanically linked to its respective internal handle. Pressing in on the forward part of the handle will extend the rear portion of the handle so that it may be grasped to unlatch and raise the hatch. If the internal handle is locked in the closed position a flush mounted pushbutton plunger, located adjacent to the external canopy handle, is provided to unlock the internal canopy handle from the outside.

CANOPY UNLOCK WARNING LAMP.

A red canopy unlock warning lamp, located on the left warning and caution lamp panel (figure 1-29), will light when either hatch is not locked. When lighted the word CANOPY is visible on the face of the lamp.

AIR CONDITIONING AND PRESSURIZATION SYSTEMS.

The air conditioning and pressurization systems (figure 1-69) combine to provide temperature-controlled, pressure-regulated air for heating, ventilating, pressurizing the cockpit and inflating the canopy seals. The system also provides air to the forward and aft electronic equipment bays, anti-icing and defog systems, windshield rain removal system, SRAM missile system and pneumatic pressure for throttle boost.

AIR CONDITIONING SYSTEM.

The air conditioning system provides temperature controlled air for the cockpit. The system also provides a temperature controlled flow of cooling air to the electronic equipment that requires a controlled environment for efficient operation. See figure 1-69. High pressure hot air is bled from the sixteenth stage compressor of each engine. This bleed air is directed through a tee fitting to a common duct and is routed through an air-to-air heat exchanger, where it is cooled by ram air that is circulated through the heat exchanger. The air is then routed through an air-to-water heat exchanger where it is further cooled and then enters the cooling turbine. The cooling turbine further cools the air to a temperature suitable for cooling the cockpit and electronic equipment bays. The cold air leaving the turbine passes through a water separator to remove most of the free moisture. A cabin temperature controller is fed signals from temperature sensors and from a pilot operated control panel. The temperature controller controls the setting of the cold air modulating valves. It also controls the setting of the cockpit hot air modulating and shutoff valve which allows hot air to mix with the refrigerated air stream, obtaining air at the selected temperature. This air then enters the cockpit through diffusers. Prior to engine start, the ground cooling air for the cockpit and electronic equipment is provided by a ground cooling cart. The receptacle for connecting the ground cart is located on the lower right side of the fuselage aft of the cockpit. In the event the air conditioning system malfunctions, emergency ram air operation is available for ventilation and cooling.

Air Conditioning and Pressurization System

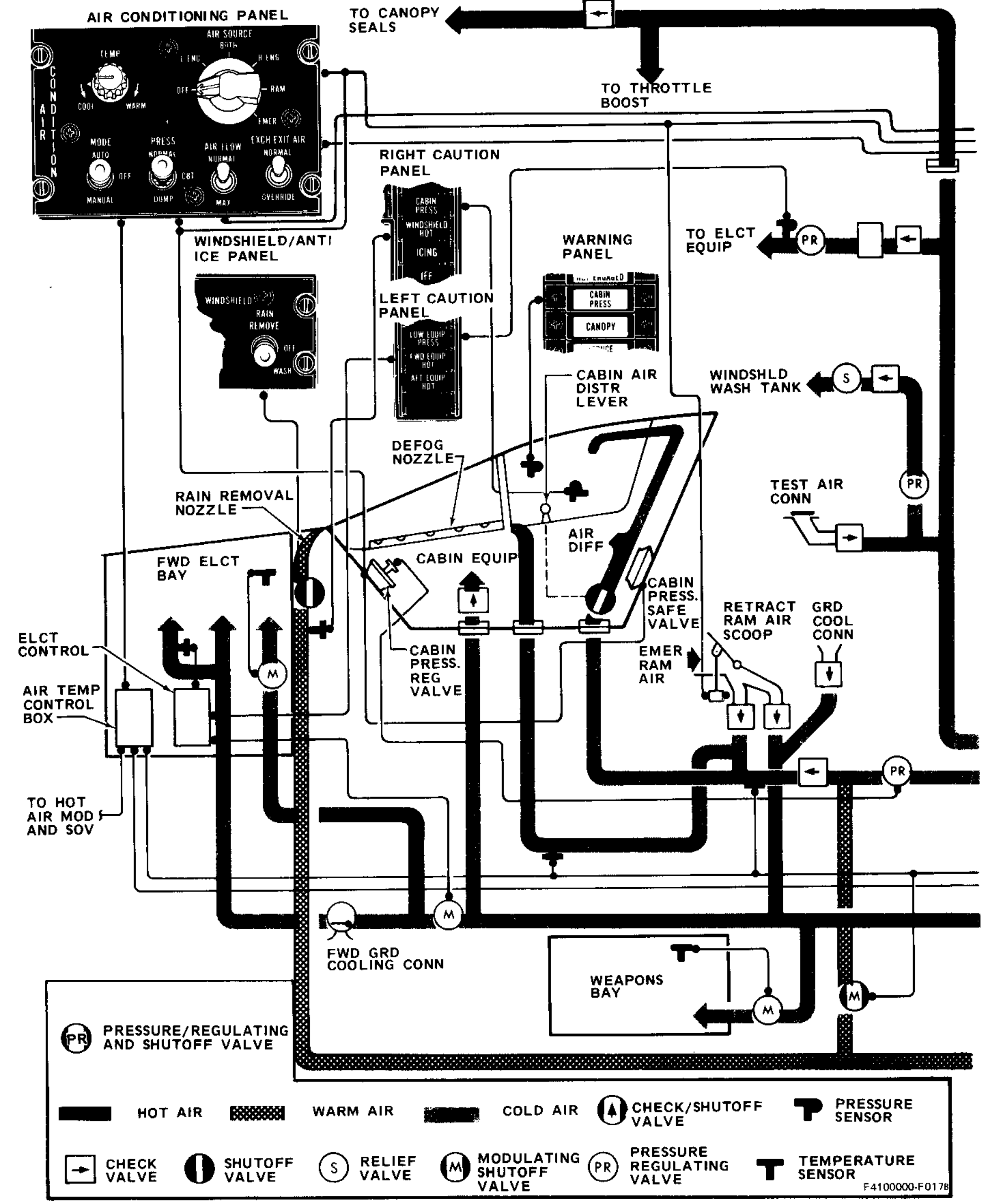


Figure 1-69. (Sheet 1)

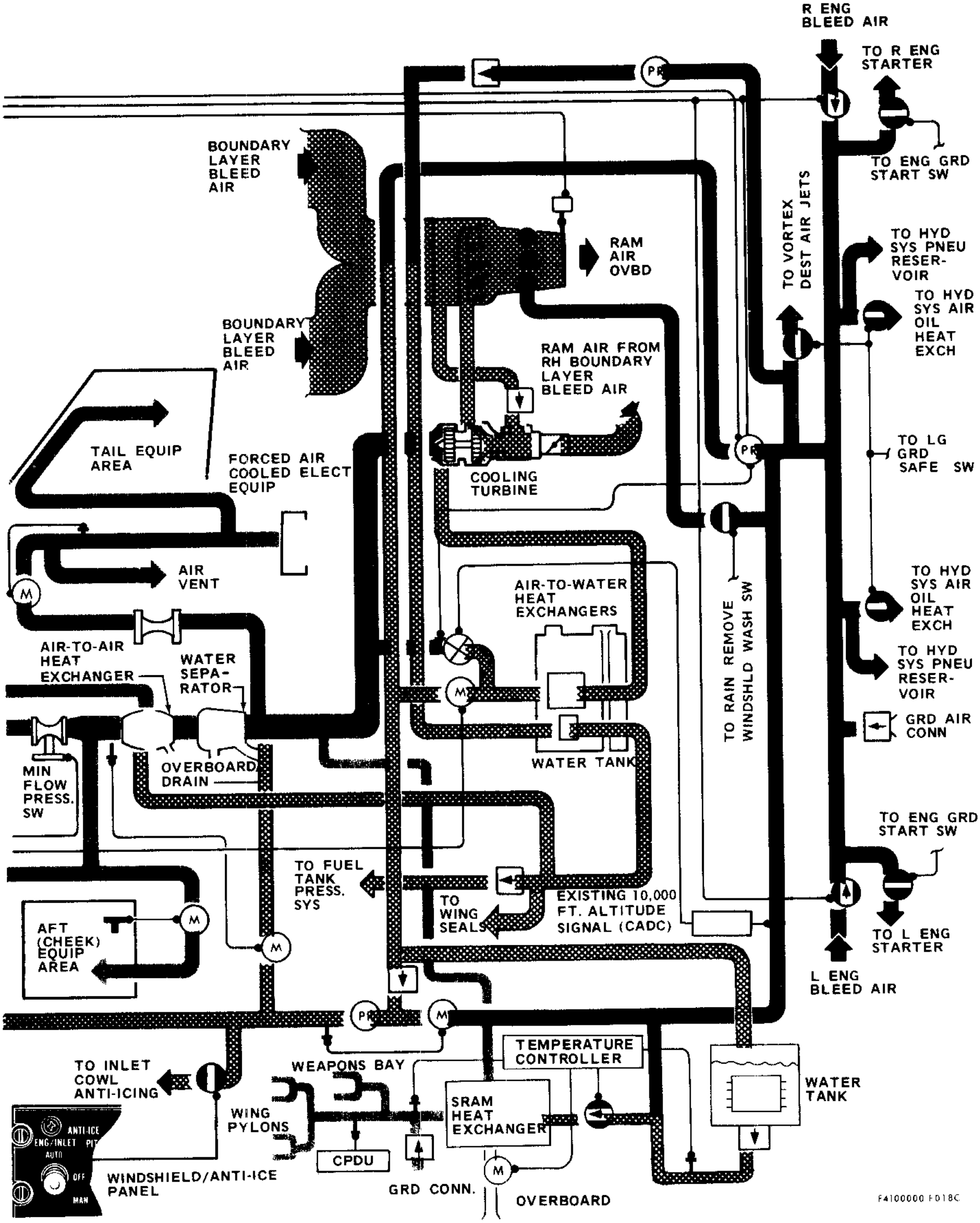


Figure 1-69. (Sheet 2)

Note

- During operation at high power settings, steam may be discharged from the air-to-water heat exchanger vent located on the lower side of the fuselage between the weapons bay doors and the main landing gear door. This is a normal condition and should be no cause for concern.
- During operations under humid conditions, rapid increases in power may induce flash freezing in the water separator causing a loss of cooling air to the cabin and electronic equipment. Normally flash freezing is of short duration (2-3 minutes), and is self-correcting. This condition may be diagnosed by observing loss of cabin airflow followed by lighting of the forward equipment hot caution lamp from 30 to 120 seconds later. The duration of this condition may be reduced by selecting full warm on the cabin temperature selector. Refer to "Caution Lamp Analysis," Section III.
- During operation at low or idle power settings the air conditioning system control valves will modulate toward an open position. When engine power is advanced high airflow will occur until the cabin temperature control valves return pressure to normal. During high cabin airflow cabin pressure may vary ±500 feet.

Cabin Air Distribution Control Lever.

A cabin air distribution control lever (49, figure 1-2), located on the aft bulkhead, controls distribution of airflow in the cockpit. The lever is labeled CABIN AIR DISTR and has two positions marked FWD DEFOG and AFT. The normal position of the lever is the AFT position. In this position airflow into the cockpit is separated between the rear bulkhead diffusers and the windshield defog system with approximately 85 percent directed to the diffusers. Moving the lever towards the FWD DEFOG position will decrease airflow through the air diffusers and increase airflow through the defog system. When the lever is in the full forward position all the airflow will be directed through the defog system. Although the AFT position is considered normal to obtain maximum airflow, desired crew comfort is accomplished by selecting any intermediate position between FWD DEFOG and AFT.

Note

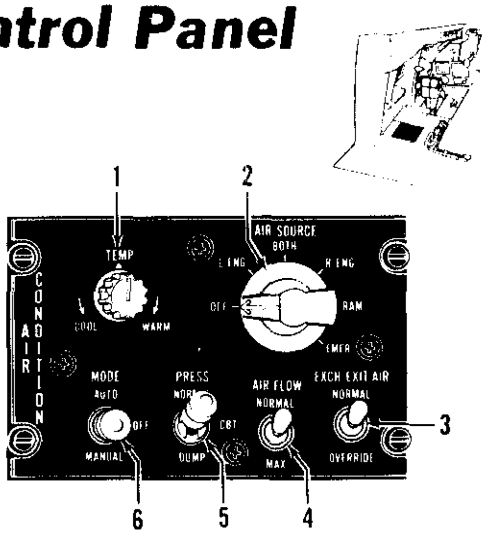
During operation at high power settings, and when airflow to the cabin is high, moisture may be sprayed on the windshield and in the crew members' face. Moving the lever toward the aft position will decrease the possibility of the condition.

Air Source Selector Knob.

The air source selector knob (2, figure 1-70), located on the air conditioning control panel, has six positions marked OFF, L ENG, BOTH, R ENG, RAM, and EMER. The knob controls bleed air source or allows selection of emergency ram air operation when the normal system is not operating. The knob controls a series of valves which operate as follows in the different knob positions:

- In the OFF position, the left and right bleed air check and shutoff valves are closed. The cold air modulating valve is open (no flow). The cabin hot air modulating and shutoff valve is modulating (no flow). The pressure regulating and shutoff valve is closed.
- In the L ENG position, the left engine is the source of bleed air, and the right bleed air check and shutoff valve is closed. The cold air modulating valve and the cabin hot air modulating and shutoff valve will be modulating in response to the position of the temperature control knob. The pressure regulating shutoff valve will be regulating.
- In the BOTH position, the left and right bleed air check and shutoff valves are open. The cold air modulating valve and the cabin hot air modulating and shutoff valve will be modulating in response to the position of the temperature control knob. The pressure regulating and shutoff valve will be regulating.
- In the R ENG position, the right engine is the source of bleed air and the left bleed air check and shutoff valve is closed. The cold air modulating valve and the cabin hot air modulating and shutoff valve will be modulating in response to the position of the temperature control knob. The pressure regulating and shutoff valve will be regulating.
- In the RAM position, the engine bleed air check and shutoff valves are open. The cold air modulating valve is open (no flow). The cabin hot air modulating and shutoff valve is modulating in response to the position of the temperature control knob. The pressure regulating and shutoff valve is closed. The ram air door is open. The RAM position will dump cabin pressure and allow combined ram air flow and regulated engine bleed air to ventilate the cabin. Temperature control of this air is available by using the temperature control knob to control the amount of engine bleed air mixed with ram air. In the RAM position bleed air pressure is available to the wing seals, fuel tank pressurization system, electronic equipment, windshield wash and rain removal, throttle boost, and canopy seals.
- In the EMER position the engine bleed air check and shutoff valves are closed and the ram air scoop is open. The EMER position dumps cabin pressure and allows ram air flow to ventilate the cabin. Temperature control is not maintained in this mode and heating is not available.

Air Conditioning Control Panel



1. Temperature Control Knob.
2. Air Source Selector Knob.
3. Exchange Exit Air Control Knob.
4. Air Flow Selector Switch.
5. Pressurization Selector Switch.
6. Mode Selector Switch.

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Figure 1-70.

CAUTION

In EMER position air pressure is not available to the wing seals, fuel tank pressurization system, electronic equipment, windshield wash and rain removal, throttle boost, SRAM missile or canopy seals.

Air Conditioning System Mode Selector Switch.

The mode selector switch (6, figure 1-70), located on the air conditioning control panel, is a three position switch marked AUTO, OFF, and MAN. The switch is a lock lever type switch which must be pulled out to change positions. In the AUTO position, the cockpit temperature is automatically controlled at the temperature selected by the temperature control knob. A signal goes to the controller which opens or closes the modulating valves to maintain the selected temperature. In the MAN position, the cockpit temperature controller is bypassed and control of the modulating temperature control valves is directly from the temperature control knob. In the OFF position, all power is removed from the system and the valves in the system, which control cabin temperature, will declutch and go to the full cool position.

Temperature Control Knob.

The temperature control knob (1, figure 1-70), located on the air conditioning control panel, is provided to select cockpit temperature. The knob can be rotated through a 300 degree arc and has mechanical stops at each end. The extreme counterclockwise end is marked COOL and the clockwise end is marked WARM. With the mode selector switch in AUTO, rotating the knob in either direction sends a signal to the cockpit temperature controller which constantly positions the modulating temperature control valves to maintain the selected temperature. When the temperature control knob is positioned at the mid-point between COOL and WARM, the cockpit temperature is maintained at approximately 19 degrees C (67 degrees F).

Note

Operation with the temperature control knob at full COOL in warm weather or full WARM in cool weather with the mode selector knob in AUTO may result in an objectionable noise with the high flow in the cockpit. The amount of airflow can be reduced by backing the knob off the full COOL or WARM position.

With the mode selector switch in MANUAL, the signal goes directly to the modulating temperature control valves, opening or closing them as directed by the signal generated from the temperature control knob. During manual operation the valves will respond only when the knob is held against a spring loaded detent at either one of the extreme positions, COOL or WARM. Maximum valve travel time from maximum cold to maximum warm is approximately 45 seconds.

Exchange (Exch) Exit Air Control Switch.

The exchange exit air control switch (3, figure 1-70), located on the air conditioning control panel, is a two position switch marked NORMAL and OVERRIDE. The switch provides a means of controlling the amount of ram airflow through the air-to-air heat exchanger by opening or closing an exit door in the ram air discharge exit. In the NORMAL position, the central air data computer automatically controls the position of the door. When the outside air temperature is below 75 degrees F and airspeed is above 225 knots the door will be closed to reduce drag. All other combinations of outside temperature and airspeed will result in automatic door opening. Placing the switch to OVERRIDE will override the automatic functions of the central air data computer and open the door to its full travel.

Note

- The air conditioning system water supply is required for supersonic flight conditions. When the water tank becomes empty at high speed flight, the system will cycle off. If this condition occurs, speed should be reduced to subsonic and the exchange exit air control switch placed to the OVERRIDE position to obtain maximum cooling. Normal system operation will be restored at subsonic flight conditions.
- When any external stores are installed, the exchange exit air control switch must be placed in the OVERRIDE position to prevent subsonic water boiling and possible shutdown of the air conditioning system.

Air Flow Selector Switch.

The air flow selector switch (4, figure 1-70), is a two position switch marked NORMAL and MAX. The switch provides a means of controlling the amount of airflow in the cabin. The NORMAL position provides cabin airflow for normal usage. The MAX position may be used for low level, high speed operation on a hot day. The MAX position may also be used during rain removal, windshield wash or for defogging.

SRAM Cooling Control Switch.

The SRAM cooling control switch (8, figure 1-72), located on the right sidewall is a two position switch marked COOLING and OFF. The switch provides a means of controlling the cooling air and regulated pressure to the missile. The COOLING position provides automatically controlled cooling air and pressure regulated to 23 ($\pm$1) psi to the missile. The OFF position turns the SRAM cooling off.

Equipment Hot Caution Lamp.

The amber equipment hot caution lamp, marked FWD EQUIP HOT, is located on the main caution light panel (figure 1-29). The lamp will light if the cooling air flow is insufficient. The following equipment is listed in the order of heat generation. The list should be used as a guide for equipment shutdown, depending on flight requirements. Shutdown may be required to prevent degraded performance and/or equipment damage from overheating.

- ECM
- Attack Radar
- HF Radio (Transmit)
- Converter Set (in operation when either WDC or GNC in operation)
- IRRS
- RHAW
- UHF Radio (Transmit)
- INS
- Astro Compass
- TACAN
- One Computer (WDC or GNC)
- Doppler Radar
- Radar Altimeter
- HF Radio (Receive)
- IFF
- UHF Radio (Receive)

Air Conditioning System Alternate Operation.

Manual Mode.

In the event of a malfunction of the cabin temperature controller, cabin temperature may be manually controlled as follows:

1. Air source selector knob—BOTH.
2. Mode selector switch—MAN.
3. Temperature control knob—Set for desired temperature.

   The temperature control knob must be held to either full COOL or full WARM position to adjust for desired temperature.

Ram Air Mode.

In the event the air conditioning system fails, ram air mode can be used for cockpit and equipment cooling. Refer to "Ram or Emergency Mode Flight Envelope," Section V. During ram air mode operation, cockpit temperature can be controlled as follows:

1. Air source selector knob—RAM.
2. Mode selector switch—AUTO or MAN.
3. Temperature control knob—Set for desired temperature.

   If the mode selector switch is positioned to MAN, the temperature control knob must be held to either full COOL or WARM position to adjust for desired temperature.

Note

Cabin cooling, in the ram mode, is limited by the ambient ram air temperature; however, cabin heating in the ram mode can be maintained as the cabin hot air supply is still available to mix with the incoming ram airflow.

PRESSURIZATION SYSTEM.

Pressurization of the cockpit, canopy seals, throttle boost, attack radar, terrain following radar, track breaker and SRAM missile is provided by the pressurization system. Pressure in the cockpit is controlled by a pressure regulating valve located in the front of the cockpit. When the aircraft is below 8000 feet, the pressure regulating valve automatically maintains an unpressurized condition in the cockpit regardless of the schedule selected. Cockpit ventilation is provided by the regulating valve continually modulating, depending on the volume of input air. A cabin pressure safety valve located at the rear of the cockpit will relieve pressure any time the cockpit pressure exceeds outside pressure by 11.2 psi. An emergency ram air scoop, which can be opened into the airstream, will admit air into the crew and electronic equipment compartments in the event of loss of cooling and pressurization air from the cooling turbine.

Note

A priority valve is incorporated into the system to ensure that electronic equipment cooling takes precedence over the cockpit.

Under conditions of high cockpit pressure differential and low airflow, such as an idle power descent from altitude, a slow depletion of cabin altitude may occur and both temperature control and defog functions will be ineffective until engine power is increased. Failure of this valve may cause forward equipment hot caution lamp to light, loss of cabin cooling airflow, unstable cabin pressurization and temperature control.

Pressurization Selector Switch.

The pressurization selector switch (5, figure 1-70), located on the air conditioning control panel, is a three position lever lock switch with positions NORMAL, CBT, and DUMP. In the NORMAL position, the cockpit pressure is selected to a schedule that will maintain an 8000 foot cabin altitude from 8000 feet up to the operational ceiling of the aircraft. In the CBT (combat) position, the cockpit maintains an 8000 foot cabin altitude from 8000 feet up to 22,500 foot altitude and then maintains a constant 5 psi differential above ambient pressure. In DUMP position, the cabin pressure regulator and the cabin pressure safety valve are open and the cockpit is not pressurized. See figure 1-71 for cockpit pressure schedule for normal and combat conditions.

Cabin Altitude Indicator.

A cabin altitude indicator (1, figure 1-15), located on the auxiliary gage panel, is provided to monitor cabin altitude.

Pressurization Caution Lamp.

An amber pressurization caution lamp marked CABIN PRESS is located on the main caution light panel (figure 1-29). The lamp will light when the cabin altitude is above 10,000 feet. When operating the cabin pressurization system in COMBAT, the cabin pressurization caution lamp will be lighted when aircraft altitude is above 26,000 feet.

Pressurization Warning Lamp.

A red pressurization warning lamp (8, figure 1-6), marked CABIN PRESS, is located on the left main instrument panel. The lamp will light when the cabin pressure is above 38,000 feet.

Equipment Low Pressure Caution Lamp.

An amber low equipment pressure caution lamp marked LOW EQUIP PRESS is located on the main caution light panel (figure 1-29). The lamp will light when the supply pressure to the pressurized electronic equipment requiring one atmosphere pressure drops below 12.5 (±0.5) psi.

Cabin Pressure Schedule

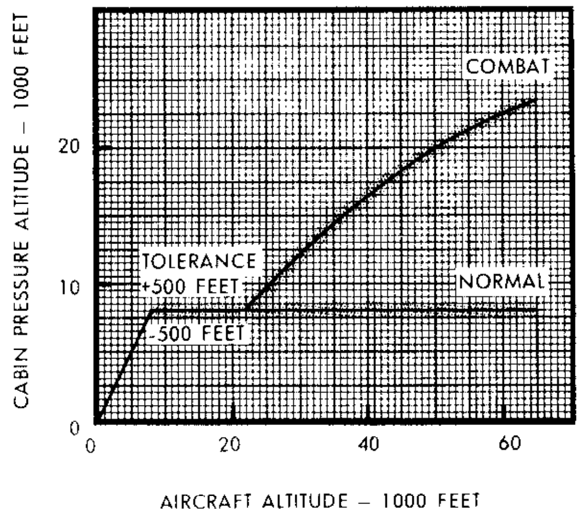


Figure 1-71.

ANTI-ICING AND DEFOG SYSTEMS.

Probe Anti-Icing.

Heating elements powered by 115 volt ac are provided on the pitot-static, total temperature and angle-of-attack and sideslip (alpha/beta) probes for anti-icing. Power for the total temperature and primary alpha/beta probe heaters is furnished from the left main ac bus. The primary pitot system heater receives power from the essential ac bus and the secondary pitot system heater receives power from the right main ac bus. The alpha/beta probe secondary and alpha/beta body heaters are furnished power from the right main ac bus. Power to the probe heater is controlled by a pitot/probe heater switch located on the windshield wash/anti-icing control panel. An alpha/beta probe caution lamp is provided to monitor the function of the heaters in the angle-of-attack and sideslip angle probes.

Right Sidewall (Typical)

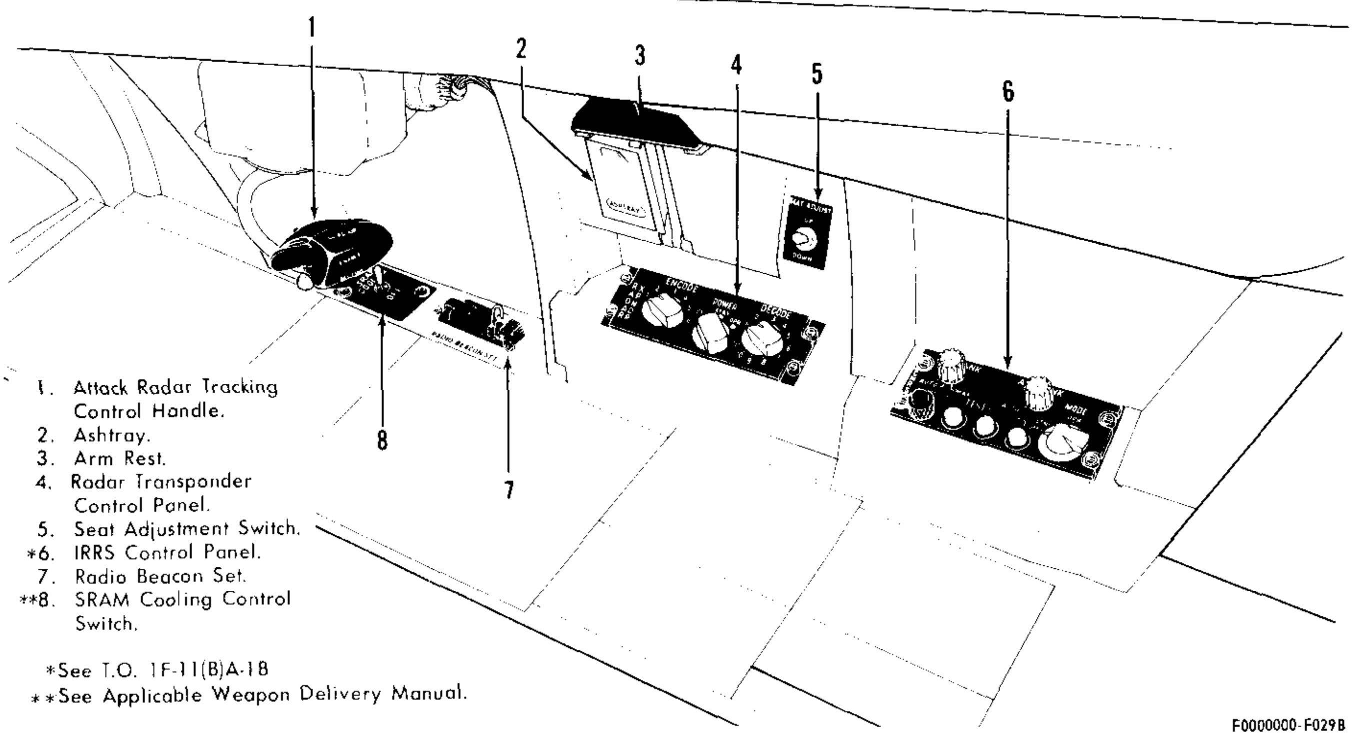


Figure 1-72.

Pitot/Probe Heater Switch.

The pitot/probe heater switch (2, figure 1-73), located on the windshield wash/anti-icing control panel, has two positions marked HEAT and OFF/SEC (secondary). The switch performs the following functions:

On the ground.

- The OFF/SEC position turns off power to the probe heaters, and lights the alpha/beta probe heat caution lamp.
- The HEAT position furnishes power to primary alpha/beta heaters, and to the pitot-static probe.

Inflight.

- The OFF/SEC position provides power to the secondary alpha/beta heaters and the pitot-static heater. The total temperature heater is off.
- In the HEAT position, power is provided to the primary alpha/beta heaters, pitot-static heater and the total temperature heater.

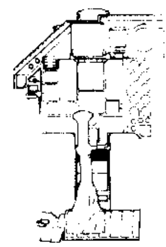
On takeoff a safety switch on the landing gear actuates to arm the secondary heater circuits in the angle of attack and angle of sideslip probes. During flight if the primary heaters in either the angle of attack or angle of sideslip probes malfunctions, the alpha/beta probe heat caution lamp will light and the secondary heater in the failed probe will be automatically energized. Momentarily placing the switch to OFF/SEC should extinguish the caution lamp while the switch remains in that position, thereby verifying that the secondary heaters are functioning properly. The total temperature probe heater does not receive power while the switch remains in the OFF/SEC position.

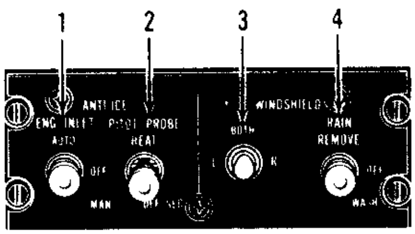
The HEAT position may be used to ground check the heater in the pitot-static probe and the primary heaters in the angle of attack and angle of sideslip probes. Proper operation of the primary heaters will be indicated by the alpha/beta probe heat caution lamp going out immediately after the switch is positioned to HEAT. The total temp probe heater may also be checked by placing the switch to HEAT and depressing the flight control master test switch and holding the CADC test switch to HIGH. Operation of the total temperature heater can be confirmed by observing an increasing temperature on the total temperature indicator.

Note

> If the total temperature exceeds 50 degrees C during ground operation, the CADS caution lamp may light and remain lighted until total temperature drops below 50 degrees C.

Windshield Wash/ Anti-Icing Control Panel





1. Engine/Inlet Anti-Icing Switch.
2. Pitot/Probe Heater Switch.
3. Windshield Selector Switch.
4. Windshield Wash/Rain Removal Selector Switch.

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Figure 1-73.

The switch controls 115 volt ac power to the heating elements in the pitot-static probe and total temperature probe, when the aircraft is airborne, and to the primary or secondary heating elements in the angle-of-attack (alpha) probe and side slip angle (beta) probes.

Alpha/Beta Probe Heat Caution Lamp.

The alpha/beta probe heat caution lamp, located on the main caution lamp panel (figure 1-29), provides indications that the angle-of-attack and/or sideslip angle probe heaters are not functioning properly as follows:

On the ground.

- Indicates the pitot/probe heater switch is in the OFF/SEC position.
- With the pitot/probe heater switch in the HEAT position, indicates the primary heater element(s) in either or both probes is malfunctioning or has overheated and has been deenergized by the thermostats.

Inflight.

- With the pitot/probe heater switch in the HEAT position, indicates the primary heater element(s) in either or both probes is not functioning.
- With the pitot/probe heater switch in the OFF/SEC position, indicates the secondary heater element in either or both probes is not functioning.

Note

The alpha/beta probe heat caution lamp is disabled at speeds above mach 1.10.

Engine Anti-Icing Systems.

The engine anti-icing system prevents formation of ice on the engine inlet guide vanes, and the engine nose cone. The engine anti-icing system uses regulated compressor bleed air. The engine inlet anti-icing system prevents formation of ice on the spike tip, the leading edge of the inlet cowl and inside the main engine air duct of the inlet cowl. The engine inlet anti-icing system uses air from the air conditioning system hot air manifold in the main landing gear wheel well. Idle rpm will provide sufficient hot air for anti-icing. The spike sensing probe anti-icing system prevents formation of ice on the spike local mach probe and spike lip shock probe. The probes are heated by 115 volt ac electrical heaters. Although the engine anti-icing, engine inlet anti-icing, and spike sensing probe anti-icing are three separate systems, they are controlled by a single, three position switch. Both automatic and manual modes of operation are provided. An electronic ice detector is located in the left engine air inlet. When icing conditions exist, a signal is transmitted to the icing caution lamp regardless of the position of the engine/inlet anti-icing switch.

Engine/Inlet Anti-Icing Switch. The engine/inlet anti-icing switch (1, figure 1-73), located on the windshield wash/anti-icing control panel, is a three position switch marked AUTO, MAN and OFF. The lever lock type switch locks in all three positions. In the AUTO position, the anti-icing circuitry is armed, and when the electronic ice detector senses an icing condition a signal is transmitted to the icing caution lamps. The signal also energizes a relay which turns on the elements in the spike sensing probe heaters and opens the engine anti-icing and engine inlet anti-icing control valves allowing the circulation of hot air through the anti-iced components. Approximately 60 seconds after the icing condition ceases, the hot air valves will close, the spike probe heating elements will be deenergized and the engine icing caution lamp will go out. When the switch is placed to MAN, the engine anti-icing and engine inlet anti-icing valves open and the spike probe heating elements are energized whether or not the ice detector senses an icing condition. Placing the switch to OFF shuts off air to the engine anti-icing and engine inlet anti-icing systems, and turns off the spike probe heating elements; however, the icing caution lamp will still be operational.

Engine Icing Caution Lamp. The engine icing caution lamp, located on the main caution lamp panel (figure 1-29), will light when the electronic ice detector senses an icing condition. While the icing condition exists,

the caution lamp will remain lighted regardless of the position of the engine/inlet anti-icing switch. The lamp will go out 60 seconds after the icing condition ceases. A malfunction within the electronic ice detector may cause the icing caution lamp to light, thus activating the engine/inlet anti-icing system if the Engine/Inlet Anti-icing switch is in AUTO. If a malfunction of the detector is known or suspected, operate the system manually by placing the engine/inlet anti-icing switch to OFF if engine/inlet anti-icing is not required, or to MAN when operation is required, under the following conditions.

Ground operation:

1. In visible moisture—Temperature between 35°F and −10°F.
2. In clean air—Relative humidity above 70 percent and dew point temperature 25°F to 35°F.

In-Flight Operation:

1. In visible moisture—Total temperature of +5°C or below.
2. In clear air—No limitations related to icing.

Inlet Hot Caution Lamp. The inlet hot caution lamp, located on the main caution lamp panel (figure 1-29), provides an indication that the temperature of anti-icing bleed air to the auxiliary cowls has exceeded 420 (±10) degrees F. When the lamp lights, the words INLET HOT are visible and anti-icing air to the auxiliary cowls is automatically shut off, then the lamp will go out.

Windshield Defog System.

Air for windshield defogging and cabin air distribution share the same control lever. For description, refer to "Cabin Air Distribution Control Lever," this section.

WINDSHIELD WASH AND RAIN REMOVAL SYSTEM.

The windshield wash and rain removal system is provided to keep both the windshields clear of impinging rain and insects. Compressor bleed air at a temperature of 390 (±10) degrees F and a pressure of 45 psi is directed over the outside of the windshields by a fixed area nozzle. This hot air blast will evaporate impinging rain and prevent further accumulation of rain on the windshield. Windshield wash is accomplished by injecting a liquid wash solution into the rain removal nozzle. This serves as a wetting and scrubbing action to remove insects from the windshields. The windshield wash solution is contained in a one gallon tank located on the right side of the nose wheel well. The tank is pressurized to 15 psi by compressor bleed air.

Windshield Wash/Rain Removal Selector Switch.

The windshield wash/rain removal selector switch (4, figure 1-73), located on windshield wash/anti-icing control panel, has three positions marked RAIN REMOVE, WASH, and OFF. The switch is spring loaded from the WASH to the OFF position and is locked out of the RAIN REMOVE position. The switch must be pulled out to move from OFF to RAIN REMOVE. Placing the switch to RAIN REMOVE will open the rain remove shutoff valves, allowing temperature and pressure regulated compressor bleed air to be directed to the windshield(s) selected by the windshield selector switch. When the switch is placed to WASH a time delay relay is energized to open the rain remove shutoff valve and the windshield wash shutoff valve selected by the windshield wash selector switch. While these valves are open, compressor bleed air and liquid windshield wash solution will be directed to the selected windshield(s). Allowing the switch to return from WASH to OFF will close the valves after a 5-second delay, shutting off the air and windshield wash solution. When the switch is in the OFF position the windshield wash and rain removal system is deenergized.

Windshield Selector Switch.

The windshield selector switch (3, figure 1-73), located on the windshield wash/anti-icing control panel, has three positions marked L (left), R (right), and BOTH. Selection of any of the positions will determine the windshield(s) to be washed or receive rain removal air as a function of the position of the windshield wash/rain removal selector switch. For optimum performance of rain removal system, operate one side only. Selection of BOTH position will decrease airflow on each windshield.

Windshield Hot Caution Lamp.

The windshield hot caution lamp, located on the main caution lamp panel (figure 1-29), indicates windshield high temperature. An overheat switch, installed in the rain removal air supply duct upstream of the shutoff valve, will close when the air temperature is above 445 (±15) degrees F. When the overheat switch closes, a circuit is completed to close the rain remove shutoff valves and light the windshield hot caution lamp. After the switch closes, the caution lamp will normally go out within 15 seconds.

WHEEL WELL OVERHEAT DETECTION SYSTEM.

A wheel well overheat detection system provides a visual indication of an overheat condition in the main wheel well area in event of a rupture in the engine bleed air lines. The function of the system is similar to the engine fire detection systems. Sensing elements,

located in the main wheel well and plumbing crossover areas aft of the main landing gear bulkhead, detect a rise in temperature and light the wheel well hot caution lamp when a predetermined temperature is reached. When an overheat condition is indicated, the air source selector knob, located on the air conditioning control panel, should be positioned to the EMER position. This will close the engine bleed air check and shut off valves to shut off the source of the hot bleed air and open the ram air door.

Note

After T.O. 1F-111-946, sensing elements are also located in the weapons bay routing tunnel and near the ac power panel. These elements are incorporated into the wheel well overheat detection circuit.

WHEEL WELL HOT CAUTION LAMP.

A wheel well hot caution lamp (figure 1-29), located on the main caution lamp panel, provides an indication of an overheat condition in the main wheel wells and plumbing crossover areas aft of the landing gear bulkheads, in event of a rupture in the engine bleed air lines. The words WHEEL WELL HOT are visible when the lamp is lighted. After T.O. 1F-111-946, this lamp also provides indications of overheat in the weapons bay routing tunnel and ac power panel area.

AGENT DISCHARGE/FIRE DETECT TEST SWITCH.

The agent discharge/fire detect test switch (2, figure 1-6), located on the left main instrument panel, provides a means of checking the wheel well overheat detection system. The AGENT DISCH position serves no function with the wheel well detection system. Positioning the switch to FIRE DETECT TEST position will light the wheel well hot caution lamp, if the wheel well detection system is operational.

FUSELAGE OVERHEAT TEST SWITCH.

The fuselage overheat test switch (6, figure 1-27), located on the ground check panel, has three positions marked LOOP 1, NORM, and LOOP 2, and is spring-loaded to NORM. This switch is used to individually check the two loops in the wheel well overheat detection system for shorts to ground. Positioning the switch to LOOP 1 puts an artificial signal (short to ground) on loop 2 and will cause the wheel well hot caution lamp to light if Loop 1 is shorted to ground. Loop 2 is checked in the same manner by positioning the switch to LOOP 2. Since the system must have a signal on both loops before it will cause the wheel well hot caution lamp to light, a short on a single loop will not prevent detection of an overheat condition.

OXYGEN SYSTEM.

The oxygen system consists of a normal (liquid) system located in the forward fuselage and cockpit and an emergency (gaseous) system located behind the cockpit aft bulkhead.

NORMAL OXYGEN SYSTEM.

The normal oxygen system consists of a 15 liter liquid oxygen converter, which converts the liquid oxygen to a gas; a heat exchanger, which heats the gas to a temperature suitable for breathing, an on-off control valve at each station and a diluter demand type regulator attached to each crew member's torso harness. A three position control knob on the regulator provides for selection of normal diluted oxygen, 100 percent oxygen and, in the event of an emergency, 100 percent oxygen under pressure.

CAUTION

Use care when connecting the oxygen regulator to the restraint harness and oxygen supply hose or when connecting the mask hose to the regulator. The valve port screens on the regulator may be easily damaged by careless or improper handling.

A quick disconnect is provided between the regulator and oxygen mask hose to expedite abandoning the aircraft on the ground. For the duration of the oxygen supply refer to figure 1-74. Refer to figure 1-80 for oxygen system servicing.

Oxygen Control Knob.

The oxygen control knob (1, figure 1-75), located on the oxygen regulator on the right side of the upper torso harness, has three positions marked NORM, 100 percent, and EMER (emergency). When the knob is positioned to NORM; oxygen, proportionally diluted with air, is supplied to the mask from 0 to 22,000 feet altitude. With the knob in the 100 percent position, 100 percent oxygen is supplied to the mask. Selecting the EMER position provides 100 percent oxygen under pressure to the mask.

Oxygen Control Levers.

Two oxygen control levers are provided to control flow of oxygen from the supply system to the oxygen regulator. Each lever has positions ON and OFF. When in the ON position, oxygen is supplied from the converter to the regulator; when in OFF, oxygen flow is shut off at the control valve in the oxygen-suit control panel. A lever is located on each crew member's oxygen-suit control panel (1, figure 1-76).

Oxygen Duration

With regulator at 100 percent or EMER position.

CABIN ALTITUDE	CONSUMPTION 2 MEN cu. ft./hr.	DURATION — HOURS*														
35,000	9.8	46.8	43.7	40.6	37.4	34.3	31.2	28.1	25.0	21.8	18.7	15.6	12.5	9.4	6.2	3.1
30,000	13.4	34.3	32.0	29.7	27.4	25.1	22.8	20.5	18.3	16.0	13.7	11.4	9.1	6.8	4.6	2.3
28,000	15.0	30.6	28.5	26.5	24.4	22.4	20.4	18.4	16.3	14.3	12.2	10.2	8.2	6.1	4.1	2.0
26,000	16.0	28.6	26.7	24.8	22.9	21.0	19.1	17.2	15.3	13.4	11.5	9.6	7.6	5.7	3.8	1.9
24,000	18.52	24.7	23.1	21.4	19.8	18.1	16.5	14.9	13.2	11.6	9.9	8.3	6.6	5.0	3.3	1.6
22,000	20.76	22.1	20.7	19.2	17.7	16.2	14.7	13.3	11.8	10.3	8.8	7.4	5.9	4.4	2.9	1.5
20,000	23.0	20.0	18.6	17.2	15.9	14.6	13.3	12.0	10.6	9.3	8.0	6.6	5.3	4.0	2.7	1.3
18,000	25.24	18.1	16.9	15.7	14.5	13.3	12.1	10.9	9.7	8.5	7.3	6.1	4.8	3.6	2.4	1.2
16,000	27.48	16.8	15.6	14.5	13.4	12.3	11.1	10.0	8.9	7.8	6.7	5.6	4.4	3.3	2.2	1.1
14,000	30.0	15.6	14.5	13.5	12.4	11.4	10.2	9.2	8.2	7.1	6.1	5.1	4.1	3.1	2.0	1.0
12,000	32.8	13.9	13.0	12.1	11.1	10.2	9.3	8.4	7.5	6.5	5.6	4.7	3.7	2.8	1.9	0.9
10,000	35.6	12.9	12.0	11.1	10.3	9.5	8.6	7.7	6.9	6.0	5.1	4.3	3.4	2.6	1.7	0.8
8,000	39.4	11.6	10.8	10.1	9.3	8.5	7.8	7.0	6.2	5.4	4.7	3.9	3.1	2.3	1.5	0.7
0	55.6	8.2	7.7	7.1	6.6	6.0	5.5	4.9	4.4	3.8	3.3	2.7	2.2	1.6	1.1	0.5
AVAILABLE OXYGEN	LITERS (LIQUID)	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
	Cu. Ft. GAS	459.0	428.4	397.8	367.2	336.6	306.0	275.4	244.8	214.2	183.6	153.0	122.4	91.8	61.2	30.6

With regulator in NORM position.

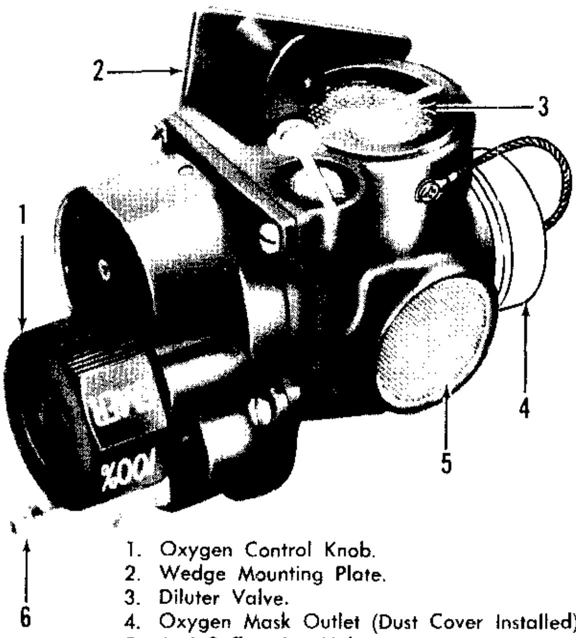
CABIN ALTITUDE	CONSUMPTION 2 MEN cu. ft./hr.	DURATION — HOURS*														
35,000	9.8	46.7	43.6	40.5	37.4	34.3	31.2	28.1	25.0	21.8	18.7	15.6	12.5	9.4	6.2	3.1
30,000	13.2	34.7	32.4	30.1	27.8	25.5	23.2	20.9	18.6	16.2	13.9	11.6	9.3	7.0	4.6	2.3
25,000	14.0	32.8	30.6	28.4	26.2	24.0	21.9	19.7	17.5	15.3	13.1	10.9	8.7	6.6	4.4	2.2
20,000	12.4	37.0	34.6	32.1	29.6	27.2	24.7	22.2	19.8	17.3	14.8	12.3	9.9	7.4	4.9	2.5
15,000	10.2	45.0	42.0	39.0	36.0	33.0	30.0	27.0	24.0	21.0	18.0	15.0	12.0	9.0	6.0	3.0
10,000	10.2	45.0	42.0	39.0	36.0	33.0	30.0	27.0	24.0	21.0	18.0	15.0	12.0	9.0	6.0	3.0
8,000	10.2	45.0	42.0	39.0	36.0	33.0	30.0	27.0	24.0	21.0	18.0	15.0	12.0	9.0	6.0	3.0
5,000	10.2	45.0	42.0	39.0	36.0	33.0	30.0	27.0	24.0	21.0	18.0	15.0	12.0	9.0	6.0	3.0
Sea Level	10.2	45.0	42.0	39.0	36.0	33.0	30.0	27.0	24.0	21.0	18.0	15.0	12.0	9.0	6.0	3.0
AVAILABLE OXYGEN	LITERS (LIQUID)	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
	Cu. Ft. GAS	459.0	428.4	397.8	367.2	336.6	306.0	275.4	244.8	214.2	183.6	153.0	122.4	91.8	61.2	30.6

*2 crew members (double duration for 1 crew member).

When available oxygen is less than 1 liter descend to below 10,000 feet MSL.

Figure 1-74.

Diluter Demand Oxygen Regulator



1. Oxygen Control Knob.
2. Wedge Mounting Plate.
3. Diluter Valve.
4. Oxygen Mask Outlet (Dust Cover Installed).
5. Anti Suffocation Valve.
6. Inlet Hose Fitting.

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Figure 1-75.

CAUTION

To prevent damage to the regulator do not actuate the lever ON or OFF with the dust covers installed.

Oxygen Quantity Indicator.

An oxygen quantity indicator is located on the right main instrument panel (16, figure 1-31). The indicator indicates the total quantity of liquid oxygen in the converter. The indicator dial is graduated from zero to 20 liters in increments of one liter. The indicator operates on 115 volt ac power from the essential bus. In the event of a power failure, the indicator pointer will freeze.

Oil/Oxygen Quantity Indicator Test Switch.

The oil/oxygen quantity indicator test switch (6, figure 1-15), located on the auxiliary gage panel, is provided to check oxygen quantity indicator. The switch has three positions marked OXY QTY, OIL QTY and is spring-loaded to the center unmarked OFF position. When the switch is held depressed to the OXY QTY position, on aircraft 7 ▸ 52 the indicator pointer will move to the zero liter indication if the indicating system is operating properly. On aircraft 53 ▸ the indicator pointer will drive in a counterclockwise direction to the zero liter indication and beyond, and will continue to drive ccw until the button is released. When the switch is released, the pointer will move to the original reading. The oxygen caution lamp will light during an indicator check when the pointer indicates a quantity of 2 liters or less. Refer to Oil System this section for the oil quantity indicator test functions of the switch.

Oxygen Caution Lamp.

An amber caution lamp on the main caution lamp panel (figure 1-29) will light when oxygen quantity indicator indicates 2 liters or less or when oxygen system pressure is less than 42 (±2) psi. When the caution lamp lights, inspection of the oxygen quantity indicator will determine whether the lamp came on because of low quantity or low pressure. When the lamp is lighted, the letters OXY will be visible on the caution lamp panel, and the master caution lamp will light. The oxygen caution lamp operates on 28 volt dc power from the 28 volt dc essential bus.

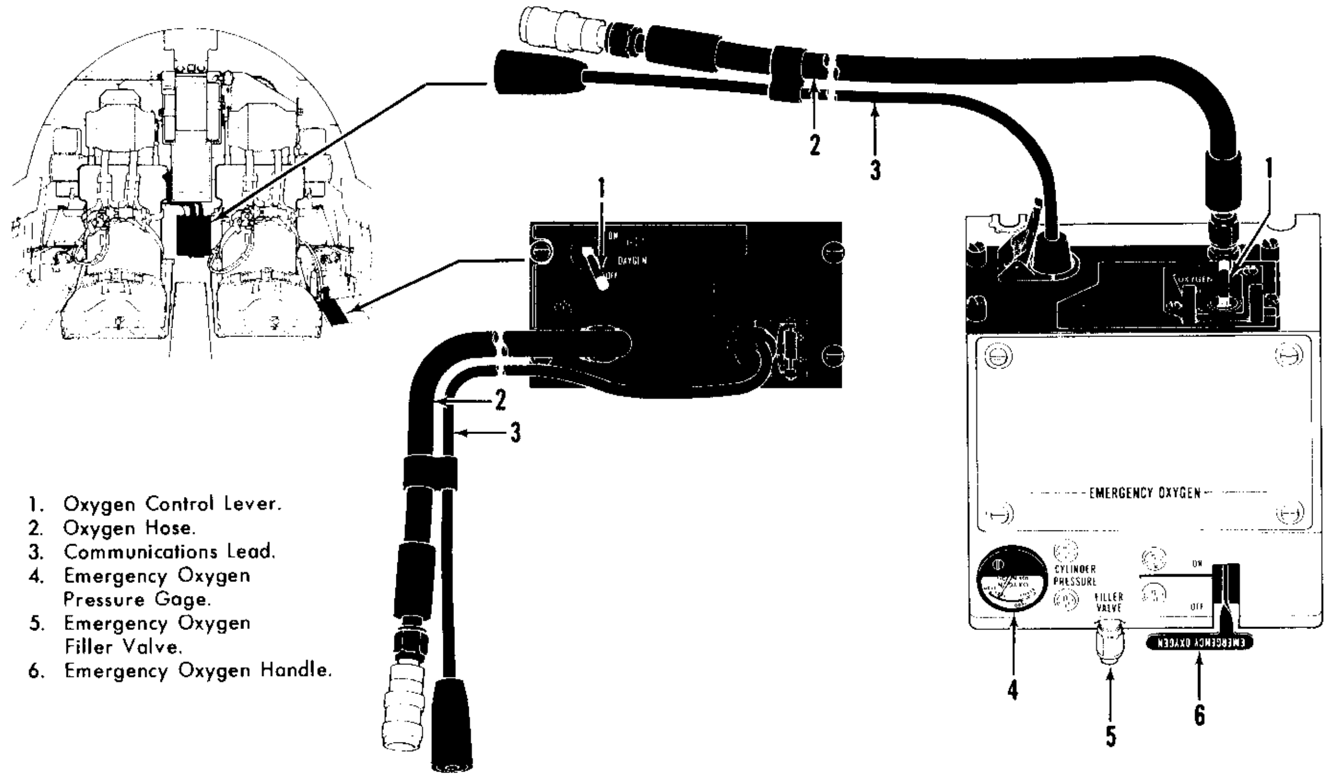
EMERGENCY OXYGEN SYSTEM.

The crew module is equipped with an emergency oxygen system consisting of two oxygen bottles, a presure reducer, a pressure gage, and a manual handle. The system is activated automatically during ejection or in event of failure of the automatic feature, it is manually activated by a handle. Also, during other phases of flight, this system provides an emergency oxygen supply in event of failure of the normal oxygen system. When activated either manually or automatically, high pressure gaseous oxygen flows to a pressure reducer where it is reduced to 50 to 90 psi. It is then routed into the normal oxygen system upstream of the oxygen control valves. Sufficient emergency oxygen is available for 10 minutes duration at 27,000 feet.

Emergency Oxygen Handle.

The green emergency oxygen handle (6, figure 1-76) is located on the right crew member's oxygen panel. During ejection, this handle is used to manually activate the emergency oxygen system in the event automatic activation fails. Also, in event of failure of the normal oxygen system during other phases of flight this handle is used to provide an emergency oxygen supply. Raising the handle will open the emergency oxygen pressure reducer allowing oxygen to flow to each oxygen control valve.

Oxygen Control Panel



1. Oxygen Control Lever.
2. Oxygen Hose.
3. Communications Lead.
4. Emergency Oxygen Pressure Gage.
5. Emergency Oxygen Filler Valve.
6. Emergency Oxygen Handle.

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Figure 1-76.

Emergency Oxygen Pressure Gage.

The emergency oxygen pressure gage (4, figure 1-76), located on the right crew member's oxygen control panel, indicates the pressure in the emergency oxygen bottles. The gage is marked REFILL in the red region and FULL in the black region with index marks at 1400 and 2500 psi.

OXYGEN SYSTEM ALTERNATE OPERATION.

If the normal oxygen system fails or is depleted, pull the emergency oxygen handle.

CREW MODULE ESCAPE SYSTEM.

The crew module (figure 1-77) forms an integral portion of the forward fuselage and encompasses the pressurized cabin and forward portion of the wing glove. Crew entrance to the module is provided through left and right canopy hatches. Refer to Canopy, this section. The system protects the occupants from environmental hazards on either land or water and provides underwater escape capabilities. An emergency oxygen supply system is provided, primarily, for use during ejection; however, the system can be manually activated during normal phases of flight, as a backup to the normal oxygen system.

WARNING

The removal or addition of components in the crew module will change the center of gravity of the module and adversely affect its stability on ejection.

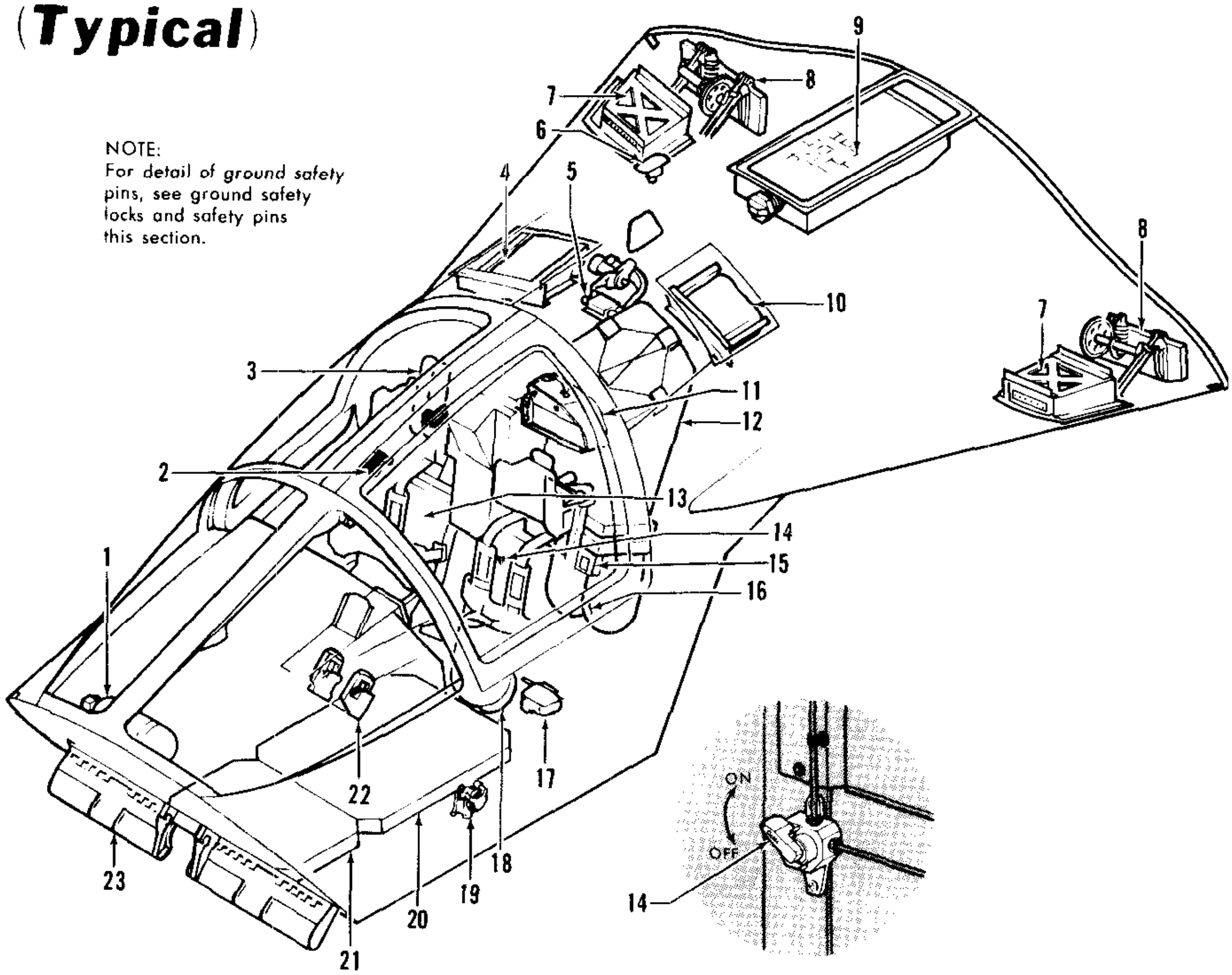
For additional information, refer to "Oxygen System", this section.

CREW MODULE SEATS.

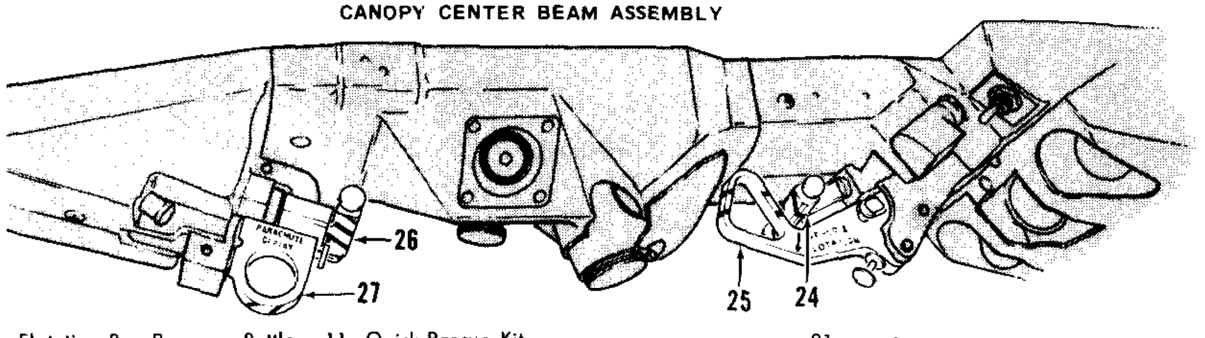
The crew module seats (figure 1-78) are electrically adjustable vertically and manually adjustable forward and aft. The seat headrest structure, which is attached to the aft bulkhead, and the seat pan are manually adjustable forward and aft. The forward adjustment of the headrest requires the inertia reel to be unlocked. The [illegible] is attached by pivot pins to the back

Crew Module General Arrangement (Typical)

NOTE:
For detail of ground safety pins, see ground safety locks and safety pins this section.



CANOPY CENTER BEAM ASSEMBLY



1. Auxiliary Flotation Bag Pressure Bottle.
2. Canopy Center Beam Assembly.
3. Emergency Oxygen Bottles (2).
4. Right Self-Righting Bag.
5. Barostat Lock Initiator.
6. Emergency UHF Antenna.
7. Aft Flotation Bag.
8. Pitch Flap (2).
9. Stabilization-Brake Parachute.
10. Left Self-Righting Bag.
11. Quick Rescue Kit.
12. Recovery Parachute.
13. Survival Gear.
14. Chaff Dispenser Control Lever.
15. Radio Beacon Set.
16. Impact Attenuation Bag Pressure Bottles (2).
17. Chaff Dispenser.
18. Rocket Motor.
19. Bilge/Flotation Bag Inflation Pump.
20. Impact Attenuation Bag.
21. Auxiliary Flotation Bag.
22. Ejection Handles (2).
23. Chin Flaps (2).
24. Recovery Parachute Release Handle.
25. Severance and Flotation Handle.
26. Auxiliary Flotation Handle.
27. Recovery Parachute Deploy Handle.

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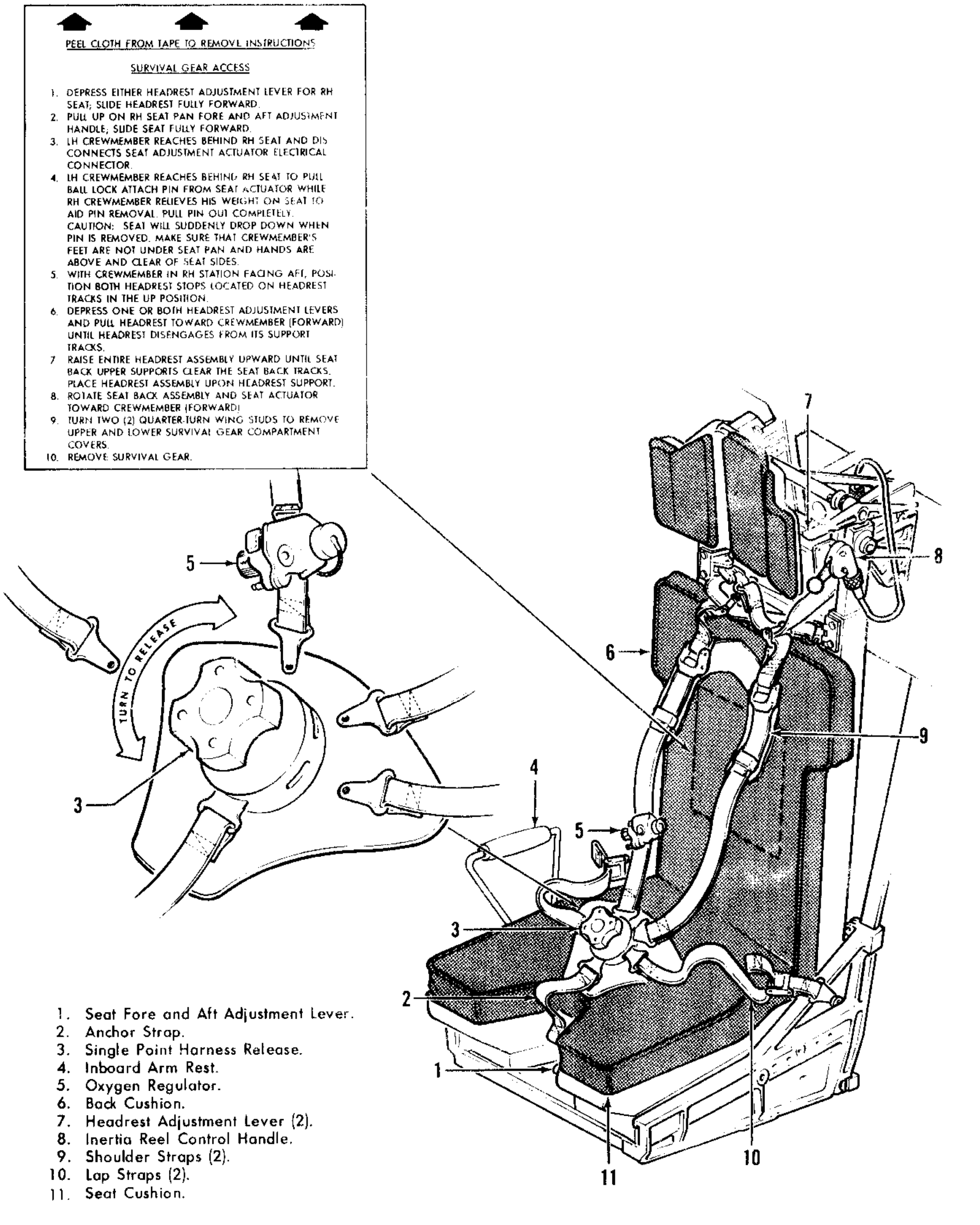
Figure 1-77.

Crew Module Seats (Typical)



1. Seat Fore and Aft Adjustment Lever.
2. Anchor Strap.
3. Single Point Harness Release.
4. Inboard Arm Rest.
5. Oxygen Regulator.
6. Back Cushion.
7. Headrest Adjustment Lever (2).
8. Inertia Reel Control Handle.
9. Shoulder Straps (2).
10. Lap Straps (2).
11. Seat Cushion.

Figure 1-78.

of the seat pan and is attached through telescopic structures to pivot pins on the headrest. Each seat is equipped with a restraint harness to protect the crew member during flight in turbulence and during ejection. The harness consists of shoulder straps and lap straps and a single point harness release attached to the front of the seat by an anchor strap. The shoulder straps are attached to the inertia reel and to the seat structure to prevent them from sliding off the crew member's shoulders. The lap straps are attached to each side of the aft seat pan. The ends of the shoulder and lap straps snap into the single point release. The single point release must be rotated 90 degrees, in either direction to release the straps. A detent at the 90 degree point will hold the release in that position. The release is spring-loaded to the center (locked) position when it is not in the detent. A wedge shaped plastic block is mounted on the right side of both types of harness to attach the oxygen regulator. Each seat is equipped with an inertia reel located behind the headrest. When unlocked, the inertia reel will allow the shoulder straps to extend or retract automatically to allow freedom of movement of the crew member. When an excessive g-force is encountered or when manually locked, the inertia reel will prevent further shoulder strap extension and will take up shoulder strap slack as the crew member returns to a normal position. The inertia reel is also equipped with an explosive cartridge in a power retraction device which, during ejection, will retract the shoulder straps and lock the reel. The right seat must be repositioned to gain access to the survival equipment compartment. Instructions for repositioning the seat are located on the back of the seat under the back cushion.

EJECTION EQUIPMENT.

The ejection equipment consists of the necessary initiators, severance components and the rocket motor. Actuation of either ejection handle initiator provides an explosive impulse sequenced to lock the shoulder harness inertia reels in the retract position, activate the emergency oxygen system, release the chaff dispenser, activate guillotine cutters, ignite the rocket motor, activate the severance components and to deploy the stabilization-brake and recovery parachutes and impact attenuation bag. The severance components consist of the flexible liner shaped charges (FLSC) and explosive guillotine cutters. The FLSC is located around the crew module so that detonation will cut the splice plate joining the crew module to the aircraft. FLSC is also used to remove the covers over the parachutes and flotation, self righting, and impact attenuation bags. The explosive guillotine cutters are provided to sever antenna leads, secondary control cables, and an oxygen line. Quick disconnects located in the crew module floor are used for separation of the normal air conditioning and pressurization system ducts, the flight controls, and the electrical wiring. The rocket motor, located between the crew members and behind the seat bulkhead, provides the thrust to propel the crew module up and away from the aircraft.

Rocket Motor.

The rocket motor has both a lower and an upper nozzle. The lower nozzle provides a normal thrust of 27,000 pounds below 300 knots. To avoid excessive g-forces to the crew members, the rocket motor is provided with two concentric upper nozzles. The small auxiliary nozzle in the center of the upper nozzle fires simultaneously with the lower nozzle to provide about 500 pounds of thrust to counteract slow speed crew module pitchup tendencies. Maximum upper nozzle thrust is achieved at aircraft speeds above 300 knots by severance of the rocket upper nozzle diaphragm. The increase in exhaust area results in reduced lower nozzle thrust (about 9000 pounds at the lower nozzle and 7000 pounds at the upper nozzle) and extended operating time. The rocket motor is located between the seat bulkhead and aft pressure bulkhead of the crew module. After ground cold soak at minus 50°F or below, it is necessary to direct warm air into the rocket motor compartment, between 80° to 120°F for 30 minutes, prior to takeoff.

Dual-Mode "Q"-Actuated Selector.

The dual-mode "q"-actuated selector continuously senses aircraft speed and selects the appropriate time delay. The symbol "q" denotes dynamic pressure. The "q"-actuated selector allows activation of a 1-second time delay initiator and blocks propagation to the rocket motor upper nozzle when aircraft speed is less than 300 knots. When aircraft speed is greater than 300 knots, the "q"-actuated selector blocks propagation to the 1-second time delay initiator and allows activation of SMDC to the rocket motor upper nozzle.

"G"-Sensor Initiator.

The "g"-sensor initiator consists of two operating trains. A rotating weighted arm, designated the rotor, in each explosive train is normally locked to prevent firing of the train. Firing of SMDC into the "g"-sensor inlet ports retracts the lock piston. Forward decelerative forces initially hold the rotors against stops. As the forces drop off, the spring-loaded rotors swing aft until they release dual firing pins. This initiates SMDC at the outlet ports and continues the detonation sequence to deploy the recovery parachute. The "g"-sensor initiator is located above the survival equipment compartment. A time delay fires the "g"-sensor initiator 1.6 seconds after rocket motor ignition. After the forward component of acceleration decreases to 2.2 "g's" the "g"-sensor initiator fires and activates the barostat lock initiator.

Barostat Lock Initiator.

The barostat lock initiator consists of two operating trains. An aneroid bellows of each explosive train in this initiator is normally locked to prevent firing of the train, constant cycling, and wearout. Firing of SMDC

into the barostat inlet ports initiates an explosive charge that retracts the pins which normally lock the bellows. The aneroid bellows prevents the firing of the explosive train above 15,000 feet. Below this altitude, atmospheric pressure compresses the bellows sufficiently to release the firing pins that initiate booster caps and continue the detonation sequence to remove the recovery parachute and blade antenna severable cover and fire the recovery parachute catapult. The barostat lock initiator is located on the explosive component support bracket in the rocket motor compartment.

RECOVERY AND LANDING EQUIPMENT.

The recovery and landing equipment consists of stabilization components, the recovery parachute, landing and flotation components. The stabilization components consist of the stabilization glove, stabilization-brake parachute, pitch flaps and chin flaps. The stabilization glove which forms the forward portion of the wing glove is an integral part of the crew module. This glove section serves to stabilize the flight of the crew module until deployment of the recovery parachute. The pitch flaps, in the under surface of the glove section, and chin flaps under the forward section, assist in maintaining crew module horizontal stability. The stabilization-brake parachute, which is contained in a compartment in the center of the top aft section of the glove, is used to decelerate the crew module and assist in maintaining stable flight prior to recovery parachute deployment. The stabilization-brake parachute is a six foot flat diameter ribbon type parachute attached by two bridles to the outboard aft sections of the glove section. The recovery parachute has a ringsail canopy with a 70 foot flat diameter. The parachute is attached by two bridles to the crew module so that the module will maintain an upright and level attitude during descent. The parachute is housed in a container located between the seat bulkhead and the aft pressure bulkhead. This container rests on the parachute catapult pan. The catapult forcibly deploys the parachute at a velocity sufficient to ensure proper bag strip-off. A dynamic pressure "q" actuated selector, monitors aircraft speed to select one of three possible time delays. One time delay train includes an acceleration "g" sensor initiator that actuates when the crew module forward deceleration drops to 2 "g's". Continuation of the firing train next unlocks the barostat initiator. When below 15,000 feet, the barostat initiator, if unlocked will fire and in turn fire the catapult to deploy the recovery parachute. The parachute is initially deployed in a reefed configuration. The parachute is disreefed by three cutters which sever the reefing line shortly after line stretch is reached. The landing and flotation components consist of an inflatable landing impact attenuation bag, flotation bags and self-righting bags. The impact attenuation bag, located in the crew module floor, inflates automatically during descent and serves to cushion the landing impact. Regulated pneumatic pressure for inflation of the bag is contained in two storage bottles in the crew module. Pressure within the bag is maintained at 2 psi. Although the crew module is watertight and will float, additional buoyancy is provided by a flotation bag at each aft corner of the glove section and by an auxiliary flotation bag at the front of the crew module. Inflation of the aft flotation bags and auxiliary flotation bag is accomplished by manually pulling the initiator handles located on the canopy center beam. The pressure source for inflation of these bags is contained in storage bottles located in the crew module. The auxiliary flotation bag is provided for use only in event of cabin flooding and in that event to gain additional freeboard to open canopy hatches. It should be reserved and not used unnecessarily. Also, its deployment will cause the crew module to ride higher in the water, thereby becoming more affected by wave action to the detriment of crew comfort. In the event the aircraft is ditched, the crew module can be separated from the aircraft by pulling the severance and flotation initiator handle located on the canopy center beam. Pulling this handle will sever the crew module from the aircraft, inflate the aft flotation and self-righting bags and turn on the emergency oxygen supply.

SURVIVAL EQUIPMENT.

The survival equipment consists of locating aids, a combination bilge/flotation bag inflation pump, two ventilation masks, standard survival equipment, and a small quick rescue kit. The locating aids consist of a chaff dispenser, radio beacon set (AN/URT-27), an ACR/RT-10A radio set, and a portable distress beacon light. The chaff dispenser, when armed, will activate to dispense chaff automatically during the ejection sequence. A control lever in the cockpit is provided to either arm or disarm the dispenser prior to ejection. The radio beacon set will emit an intermittent, modulated tone to aid in rescue operations. The set is located behind the left seat. The set is connected to the crew module mounted emergency UHF antenna which erects upon ejection. The set may also be used as a portable utilizing its own retractable antenna. The ACR/RT-10A radio, located in the survival equipment stowage compartment, provides a means of two way voice communications. The portable distress beacon light, also located in the survival equipment stowage compartment, produces a powerful flashing light to aid in night rescue operations. The combination bilge/flotation bag inflation pump is operated by fore and aft motion of the control stick. This will cause simultaneous pumping of water overboard and inflation of the flotation bags. Over-inflation of the bags is prevented by relief valves. The air ventilation masks located in the survival equipment stowage compartment are provided for use when the canopy hatches must remain

closed because of rough seas or inclement weather. The mask hoses may be connected to air mask connector (snorkel) valves located adjacent to the crew seats. An air supply tube leads from each connector valve to an outside opening well above the water line. On aircraft 23 ▶ provisions for the air ventilation masks have been deleted. Standard survival equipment is provided for all climatic conditions. This equipment is stored in the survival equipment stowage compartment behind the right seat. Instructions on how to gain access to the survival equipment compartment are contained on a detachable instruction plate mounted on the back of the right seat behind the back seat cushion. The contents of the survival equipment stowage compartment will be determined by the applicable using command. A small quick rescue kit containing survival equipment useful for rescue aid in hostile territory when early rescue is expected is mounted on the rear bulkhead above the left headrest. Two bags inside the kit are readily accessible to the crew in the event the situation demands that the crew abandon the module immediately after landing. On aircraft modified by T.O. 1F-111(B)A-579, the quick rescue kit has been moved on the rear bulkhead to above the right headrest.

WARNING

Crew members should not keep sharp or bulky items in upper torso pockets to avoid personal injury or interference with restraint harness operation during power retraction of the inertia reel.

CREW MODULE EJECTION SEQUENCE.

WARNING

Under certain conditions of crew module weight and/or tail wind, zero altitude and zero airspeed, ejection capability may not be available. Because of the variables involved, ejection should not be attempted at zero altitude with less than 50 KIAS.

The ejection sequence is initiated by squeezing and pulling either ejection handle located on the center console. All succeeding functions through landing are automatically actuated by dual explosive firing trains. Emergency oxygen system actuation is automatic, however, a manually actuated backup handle is available if required. The recommended ejection posture if time permits is: head against headrest, feet on rudder pedals, and hands in lap. Seat prepositioning is not necessary. After a delay of 0.35 second to allow for powered repositioning of crew members, the crew module is severed and the rocket motor is ignited. The noise of ejection will be loud but of short duration. Full thrust is sustained for approximately 1.0 second. Crew members may expect moderate ejection accelerations at low speeds becoming more severe at very high speeds. During the first six inches of crew module separation, pitch flaps and stabilization (chin) flaps rotate down into deployed position. Their function is to control crew module trim angle of attack and resulting spinal accelerations. The stabilization-brake parachute is deployed 0.15 second after crew module severance. This parachute provides necessary acceleration control and stabilization at speeds above 450 knots. Crew module pitch control at high speeds is provided by firing the rocket motor upper nozzle. Recovery parachute deployment is timed by a sequencing system which senses speed, acceleration, and altitude upon ejection. This system consists of three time delays (1.0, 1.6, and 4.4 seconds), a "q"-actuated selector, a "g"-sensor initiator, and a barostat lock initiator. The 4.4 second delay serves as a safety backup to the other sequencing components. At speeds below 300 knots and altitudes below 15,000 feet, the recovery parachute is deployed after a 1.0 second delay. At speeds above 300 knots and altitudes below 15,000 feet, recovery parachute deployment is controlled by a "g"-sensor initiator and is, thereby, delayed until crew module longitudinal (fore and aft) deceleration drops to a 2.2 "g's." This allows the crew module to decelerate to below the design limit airspeed of the recovery parachute. At altitudes above 15,000 feet, deployment is constrained by a barostat lock initiator. The barostat lock initiator is armed by one of three explosive trains, whichever fires first; these are from the "q"-actuated selector, the "g"-sensor initiator, or a 4.4 second time delay initiator. After the barostat lock initiator is armed and after the crew module falls through 15,000 feet, ambient pressure compresses the aneroid bellows causing the initiator to fire. The recovery parachute is then deployed upward at 45 feet per second. Manual deployment capability, which is operable at the crew member's discretion by means of the parachute deploy handle, is provided as a backup to the automatic barostat system.

WARNING

The parachute deploy handle bypasses the barostat lock initiator. It should not be actuated above 15,000 feet, as read on the standby altimeter, otherwise failure of the recovery parachute may result.

The initial recovery parachute inflation and the associated opening shock loads are controlled by a reefing line that holds the parachute canopy opening to about 8 feet diameter. Parachute disreefing to full inflation occurs 2.5 seconds after suspension line stretch. Whereas free-fall from maximum altitude to 15,000 feet occurs in 85 seconds, the remaining descent time after recovery parachute deployment is about 7.5 minutes. Chaff deployment as an aid to radar tracking and automatic emergency UHF radio transmission occurs 3.0 seconds after ejection handles are actuated if the chaff control lever is in ON position. The crew module repositions to its horizontal landing attitude and the emergency UHF antenna erects 7.0 seconds after recovery parachute deployment. A mild explosive report will be heard and a sudden dropping of the tail of the crew module will occur upon repositioning. Landing impacts are absorbed by the impact attenuation bag, which is fully inflated 7.25 seconds after recovery parachute deployment. Canopy hatches may be opened during descent, but prior to landing hatches should be closed in case of overturning. If restraint harnesses are loosened, the crew member should assume ejection posture and tighten the harness prior to landing. Oxygen masks should be worn until the module has been vented of possible toxic gases. Crew members may expect moderate landing impact decelerations for the nominal weight crew module. It is recommended that the severance and flotation handle be pulled immediately after ground or water impact; this will expose the chute release handle that should be pulled to avoid being dragged or overturned in high winds.

WARNING

- Do not actuate the severance and flotation handle when personnel are within 100 feet of the crew module because of explosive severance of metal covers.
- Do not actuate the severance and flotation handle prior to impact. To do so will result in severe post-landing gyrations if on land or rupture the bags if on water.

In calm or no-wind conditions, it may not be necessary to release the recovery parachute.

EJECTION WITH SUSPECTED PITOT-STATIC SYSTEM FAILURE.

A failure in the pitot-static system (secondary pitot-static system after T.O. 1F-111(B)A-554) will affect crew module performance in a number of ways.

1. If pitot-static system speed inputs are erroneous and are less than 300 KIAS the crew module "q" actuated selector will program the ejection in the low speed mode regardless of aircraft speed. In this event at actual aircraft speeds greater than 300 knots, high spinal loading, serious structural damage and recovery parachute failure may occur. At actual speeds below 300 knots, ejection will not be affected.
2. If pitot-static system speed inputs are erroneous and are greater than 300 KIAS the crew module "q" actuated selector will program the ejection in the high speed mode regardless of aircraft speed. In this event at actual aircraft speeds less than 300 knots, an additional 0.6 seconds will be added to recovery sequence times and the rocket motor will fire in the high speed mode resulting in degraded recovery height performance. At actual speeds above 300 knots, ejection will not be affected.

DITCHING ESCAPE SEQUENCE.

If the aircraft is ditched, crew module severance and flotation bag deployment may be initiated manually by pulling the severance and flotation handle. When the handle is pulled the following sequence of events occurs: An initiator is fired to (1) fire the FLSC to separate the crew module from the aircraft, (2) remove the severable covers over the aft flotation bags and the self-righting bags, (3) fire the explosive valve in an air storage bottle to inflate the aft flotation bags and the left self-righting bag and (4) fire the explosive valve in an air storage bottle to inflate the right self-righting bag.

WARNING

Pulling the severance and flotation handle and the auxiliary flotation handle does not disable the rocket motor; it will still fire if either ejection handle is pulled. To preclude inadvertent firing of the rocket motor during the ditching sequence, both ejection handle safety pins must be installed.

Seat Fore and Aft Adjustment Lever.

The seat fore and aft adjustment lever (1, figure 1-78), located in front of the seat pan between the crewmember's legs, is provided to unlock the seat from the carriage to allow forward and aft adjustment. When the handle is pulled up, the seat will unlock to allow a maximum of 5 inches travel from full aft to full forward. Since this lever does not provide headrest adjustment, forward and aft adjustment of the seat will result in a tilting of the seat back.

Seat Adjustment Switches.

Vertical adjustment of each seat is provided by a switch located on each left and right sidewall (5, figure 1-25 and 5, figure 1-72) adjacent to the seat. Each switch has positions marked UP and DOWN and is spring-loaded to the center unmarked OFF position. Positioning a switch to either UP or DOWN energizes an electrical actuator to raise or lower the seat as selected. The seat has a maximum vertical travel of 5 inches.

Headrest Adjustment Lever.

A headrest adjustment lever (7, figure 1-78), located on either side of each seat headrest is provided for fore and aft adjustment of the headrest. Depressing either lever will unlock the headrest allowing it to be moved either forward or aft. Releasing the lever will lock the headrest in place. Since the seat back is attached to the headrest, fore and aft movement of the headrest will cause the seat back to tilt.

Inertia Reel Control Handle.

The inertia reel control handle (8, figure 1-78), located on the left side of each seat headrest, is provided to lock or unlock the inertia reel. When the handle is in the up position the inertia reel is locked. Pulling down on the handle unlocks the inertia reel and the restraint harness can be pulled out.

Ejection Handles.

Two ejection handles (22, figure 1-77), one located on either side of the center console adjacent to the crewmember's seat, are provided to initiate the ejection cycle. When the lock release on the top of handle is depressed the handle is released and may be pulled out. Pulling the handle out approximately ½ inch will fire the initiator to start the ejection sequence.

Recovery Parachute Deploy Handle.

The ring-shaped recovery parachute deploy handle (27, figure 1-77), located on canopy center beam assembly, is provided as an emergency means of deploying the recovery parachute should the normal method fail. Pressing a release button and pulling the handle will fire an initiator to deploy the parachute.

WARNING

Use caution to avoid inadvertent actuation of the recovery parachute deploy handle in flight prior to ejection. The parachute would deploy immediately with catastrophic results since there is no means of recovery parachute jettison with the module attached to the aircraft.

Recovery Parachute Release Handle.

The T-shaped recovery parachute release handle (24, figure 1-77), located on the canopy center beam assembly, is provided to release the recovery parachute from the crew module after landing. Pressing a release button on either side of the handle and pulling the handle fires the parachute release retractors at the bridle attaching points releasing the bridles from the crew module. The recovery parachute release handle cannot be pulled until the severance and flotation handle has been pulled.

WARNING

Do not pull the handle prior to landing as the parachute will separate from the crew module allowing the crew module to free fall.

Auxiliary Flotation Handle.

The T-shaped auxiliary flotation handle (26, figure 1-77), located on the canopy center beam assembly, is provided to inflate the auxiliary flotation bag on the front of the crew module. Pressing a release button on either side of the handle and pulling the handle out fires an initiator which in turn removes the severable cover over the auxiliary flotation bag and fires an explosive valve in an air storage bottle to inflate the bag.

Severance and Flotation Handle.

The severance and flotation handle (25, figure 1-77), located on the canopy center beam assembly, is provided for escape in the event the aircraft is ditched. Pressing a release button on the lower side of the handle and pulling the handle down will fire the FLSC and guillotines, separating the crew module from the aircraft, and will inflate the aft flotation bags and the self-righting bags. Pulling the handle will also activate the emergency oxygen system. The rocket motor is not ignited in this sequence; however, it is not disabled and will still fire if either ejection handle is pulled.

Bilge/Flotation Bag Inflation Pump.

The bilge/flotation bag inflation pump (figure 1-79) provides simultaneous inflation of the flotation bags and pumping of water overboard. The pump is operated by fore and aft motion of the control stick. After landing, the bilge pump lock pin is removed from the pin stowage hole and inserted in the operating hole. This connects the pump to the control stick. A plunger, adjacent to the pin stowage hole, must be pushed in to open the pump air and water outlet valves. Movement of the stick will then operate the pump.

WARNING

Do not engage the bilge pump until after ejection. To do so will prevent the cabin pressure regulator from relieving cabin pressure and the canopy hatches may be blown off when they are opened during normal operation.

Chaff Dispenser Control Lever.

The chaff dispenser control lever (14, figure 1-77), located on the aft bulkhead, is used to arm or disarm the crew module chaff dispenser. The lever is labeled CHAFF and has two positions marked ON and OFF. Placing the lever to the ON (up) position opens a mechanical interrupt to allow explosive train propagation to the chaff dispenser release mechanism. When the crew module is ejected, the explosive train releases the chaff dispenser and the slip stream dispenses the chaff. Placing the lever to the OFF (down) position closes the mechanical interrupt, thereby disarming the dispenser. When the lever is in the ON position, the radio beacon set will be automatically activated as the crew module ejects.

Bilge/Flotation Bag Inflation Pump

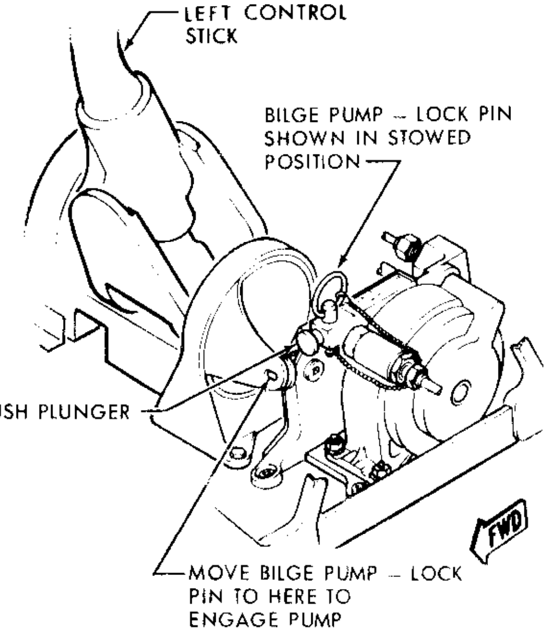


Figure 1-79.

MISCELLANEOUS EQUIPMENT.

THERMAL RADIATION PROTECTION.

Thermal radiation protection for the crew is provided by side curtains on the canopy hatches and hinged forward panels located between the glare shield and windshield.

Side Curtains.

The side curtains (11, figure 1-2) are mounted along the upper edge of each canopy hatch on either side of the center canopy beam. When stowed the curtains are folded as an accordion in the shape of a fan with the hinge forward. As each curtain is extended it unfolds to form an arc from the top rear to the bottom forward edge of the hatch. The rim of the arc rides in a track to form a light seal. When fully extended the forward edge of the curtain forms a light seal against the forward hatch structure, thus completely covering the canopy hatch glass. The curtain is retained in the stowed position by a two position magnetic latch to assist in proper operation of the curtain. A handle labeled RADIATION CURTAIN is provided on the forward edge of the curtain to extend or retract the curtain. A position latch on the forward seal locks the curtain in the extended position. A push button labeled CURTAIN RELEASE must be depressed to release the curtain for retraction. A decal located adjacent to the curtain release button contains instructions for extending or stowing the curtain.

Forward Panel.

The forward panel is constructed in sections to form a thermal radiation shield across the front of the cockpit between the top of the glare shield and the windshield arch frame. The panels are hinged along the aft edge of the glare shield and fold forward to lie on top of the glare shield when not needed. A slide catch on each side secures the panels against the glare shield. A cable lanyard attached to each of the two slide catches is provided to unlatch the catch and erect the shields. The right section must be raised first. When erected a friction catch retains the upper edge of each section against the windshield arch to provide a light seal. To stow the panel each crew member disengages the friction catch by pushing forward on his section adjacent to the catch. When disengaged the panels will fall forward on the glare shield. The slide catches on each side should be engaged to retain the panel in the stowed position. A decal located on the forward canopy hatch structure contains instructions for erecting and stowing the panels.

CREW ENTRANCE LADDERS AND STEPS.

Crew entrance ladders and steps, located on each side of the fuselage, provide crew access to the cockpit without the aid of ground support equipment. When not in use both sets of ladders and steps are retracted into the sides of the fuselage. Each left or right ladder and step can be electrically extended from inside the cockpit. Slotted head releases are provided on the outside of the fuselage to manually extend the ladders and steps from the ground. The ladders and steps must be manually stowed from the ground.

Entrance Ladder Switch.

The entrance ladder switch (4, figure 1-27), located on the ground check panel, is labeled LADDER and has three positions marked L (left), R (right) and OFF. Placing the switch to L or R will provide 28 volt dc power to solenoids in the respective ladder and step to release and extend the ladder and step. The switch is spring-loaded to the center OFF position.

MIRRORS.

Four rear view mirrors, two on each side of the cockpit canopy frame (9, figure 1-2) are installed to permit the crew rearward vision without moving from their normal sitting position. The mirrors are adjustable in tilt only.

MISSION DATA BOX STOWAGE.

A mission data box (38, figure 1-2) is located at the aft end of each left and right console at the bottom of the aft bulkhead. The boxes are provided to stow classified mission data in the aircraft for each crew member. Each box has a combination lock to secure the lid shut and a lanyard from the box to the aircraft. The boxes are secured in their mounting brackets by sliding type fasteners. The lid on each box is spring loaded to the open position. Provisions are available on the box for a security seal to be installed when required.

CHART STOWAGE.

Two chart stowage compartments are located on each side of the lighting control panel (46 and 52, figure 1-2). The left compartment is labeled LETDOWN CHART HOLDER; the right compartment is labeled LETDOWN CHARTS. Each compartment is provided with a strap and fastener to secure the charts and holder.

SAFETY PIN STOWAGE.

A stowage compartment (53, figure 1-2), located on the aft bulkhead outboard of the left seat is provided to stow the safety pins.

SPARE LAMP AND FUSE HOLDER STOWAGE.

A stowage compartment (44, figure 1-2), located on the aft bulkhead outboard of the right seat is provided for stowing spare light bulbs and fuses.

FOOD AND LIQUID STOWAGE.

A food and liquid stowage compartment (42, figure 1-2) for each crew member is located on the aft bulkhead outboard of each crew member's seat. The stowage is in two sections, one for food, the other for liquid. The door on the food section is spring loaded to the open position and is closed with a lever type fastener. The liquid bottle is secured below the food compartment with sliding fasteners. A valve located on the bottom of the bottle dispenses a given amount of liquid when the cup is properly engaged and depressed. The stowage compartment may be rotated out of the way when not in use by activating the unlock lever at the front and swinging the whole unit aft and up about a pivot point until it latches in the up position. When use of the food and liquid is desired, grasp the latch and pull down. This will unlatch the stowage compartments, and further pulling on the latch handle will rotate the compartment to a using position.

DRINKING CUPS.

Drinking cups (40, figure 1-2), located on the left and right sidewall are provided for each crew member. The cups are stowed in a spring clip when not in use. The cups are equipped with an anti-splash baffle to reduce accidental spilling.

ASH TRAYS.

An ash tray (7, figure 1-25 and 2, figure 1-72) located on the left and right sidewall is provided for each crew member. Each ash tray may be opened by pulling a handle at the top and closed by pushing the handle outboard.

RELIEF CONTAINER STOWAGE.

A relief container (39, figure 1-2), located just aft of the left and right consoles is provided for each crew member. Each container lid is held shut with a lever type latch. A bracket inside each lid holds four relief bags.

WEIGHT AND BALANCE T.O. AND FLIGHT RECORD STOWAGE.

The weight and balance T.O. and flight record stowage (41, figure 1-2) is located on the aft bulkhead outboard of the right seat. The manuals are stowed in a bracket and held in place by a lid which is spring loaded to the open position. To close the lid push aft until it comes in contact with a lever latch. Lifting up on the latch releases the lid which opens automatically.

FLIGHT MANUAL STOWAGE.

The flight manual stowage (56, figure 1-2) is located on the aft bulkhead outboard of the left seat. The manuals are stowed in a bracket and held in place by a lid which is spring loaded to the open position. To close the lid push aft until it comes in contact with a lever latch. Lifting up on the latch releases the lid which opens automatically.

IFR CHART STOWAGE.

The IFR chart stowage (57, figure 1-2) is located at the aft end of the left console, outboard of left seat. The charts are stowed and removed by pushing a spring loaded keeper to one side, which springs back in position when released. This stowage box is mounted in the aircraft with slide fasteners and must be removed to gain access for removal of the mission data box.

HOOD STOWAGE COMPARTMENT.

A hood stowage compartment (45, figure 1-2) is located on the right seat above the headrest and provided to store the attack radar scope hood. On aircraft modified by T.O. 1F-111(B)A-579 the hood stowage compartment is above the left seat.

CORRECTION CARD HOLDERS.

Card holders are provided under the glare shield for EPR setting, compass correction and UHF frequency channels. Each card holder is attached by spring tensioned hinges riveted to the glare shield. The card holders are pulled out into position for reading purposes and spring back against the lower side of glare shield when released.

CHART HOLDER.

A lighted chart holder is provided to clearly display approach charts where they can be easily followed during instrument letdowns. The holder is a rectangular transparent pane the size of an approach chart and is attached in a swivel socket on the canopy center beam. It can be swivelled to the left or right and latched in place for use by either crew member. The holder has both red and white lighting which can be mixed as desired by control knobs located on the top of the holder. The holder is stowed in a receptacle (52, figure 1-2), located in the aft console, when not in use.

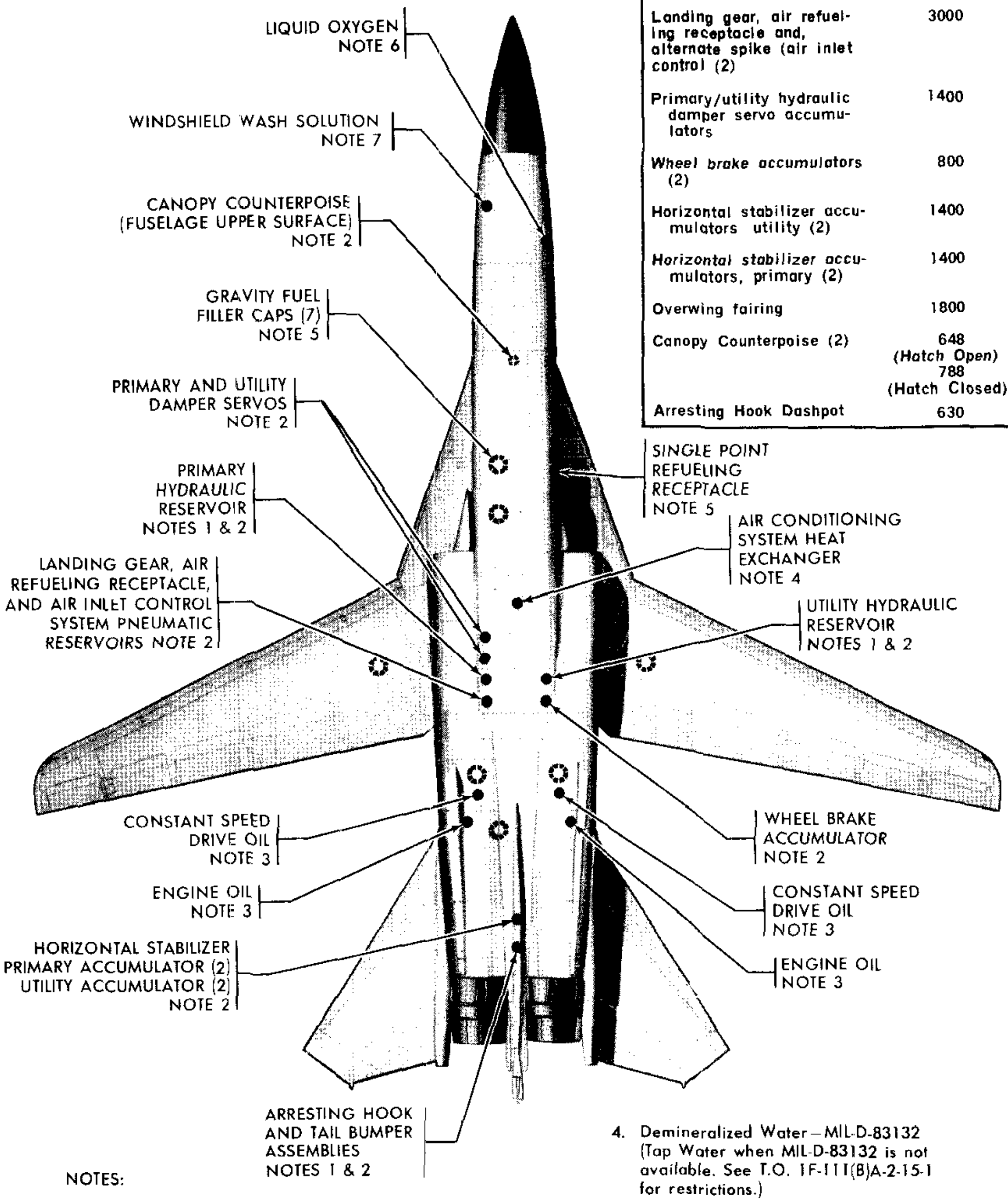
STARTER CARTRIDGE STOWAGE CONTAINER.

A starter cartridge stowage container, located on the left forward side of the main landing gear wheel well, is provided to carry two spare starter cartridges. The container is made of plastic and has a detachable cover to allow servicing or access to the spare cartridges when needed.

Servicing Diagram

PNEUMATIC SERVICING REQUIREMENTS TABLE

SYSTEM or COMPONENTS	PRESSURE (PSIG) (AT 70°F, 21°C)
Landing gear, air refueling receptacle and, alternate spike (air inlet control) (2)	3000
Primary/utility hydraulic damper servo accumulators	1400
Wheel brake accumulators (2)	800
Horizontal stabilizer accumulators utility (2)	1400
Horizontal stabilizer accumulators, primary (2)	1400
Overwing fairing	1800
Canopy Counterpoise (2)	648 (Hatch Open) 788 (Hatch Closed)
Arresting Hook Dashpot	630



NOTES:

1. Hydraulic Oil—MIL-H-5606
2. Nitrogen-FS BB-N-411, Type 1, Class 1, Grade B or Air – MIL-P-5518
3. Oil—MIL-L-7808
4. Demineralized Water—MIL-D-83132 (Tap Water when MIL-D-83132 is not available. See T.O. 1F-111(B)A-2-15-1 for restrictions.)
5. Fuel—MIL-T-5624 (JP-4)
6. Liquid Oxygen—MIL-O-27210, Grade B, Type II
7. Wash Solution—Refer to T.O. 1F-111(B)A-2-1.

F0000000-F023C

Figure 1-80.

SECTION II

NORMAL PROCEDURES

TABLE OF CONTENTS.

Note

- Items coded **B** are applicable to both the pilot and navigator. Items coded **N** are applicable to the navigator only and uncoded items are applicable to the pilot only. Where a procedure is designated (Nav Reads) he need read only those items that require pilot coordination.
- Items coded (GO) require action by the ground observer. A ground observer's checklist is included in the abbreviated flight crew checklist in the 1F-111(B)A-1CL-1.
- Items coded † must be checked against the applicable weapon delivery manual and individual aircraft retrofit to determine applicability.
- The airspeed indicated on the airspeed mach indicator has been calibrated for pitot-static system errors by the CADC and therefore is actually KCAS (knots calibrated airspeed). However, this air speed is referred to as KIAS (knots indicated airspeed) throughout this manual since it is read directly from the instrument.

PREPARATION FOR FLIGHT.

FLIGHT RESTRICTIONS.

Refer to Section V for the operating limitations imposed on the aircraft.

FLIGHT PLANNING.

Accomplish mission planning in accordance with procedures outlined in Section IV and Appendix I. Accomplish crew briefing to include normal and emergency procedures to insure safe and successful completion of the flight.

TAKEOFF AND LANDING DATA CARDS.

Refer to the Performance Appendix for information necessary to complete the Takeoff and Landing Data Card in the Flight Crew Checklist, T.O. 1F-111(B)A-1CL-1.

WEIGHT AND BALANCE.

Refer to Section V for weight limitations and to the Manual of Weight and Balance Data, T.O. 1-1B-40, for aircraft and crew module loading information.

WARNING

The crew module should not be considered flyable without its full crew and complement of survival equipment, or the equivalent ballast to maintain center of gravity. In the event that combined crew weight, including personal equipment, exceeds 430 pounds or weight differential between the two occupants exceeds 65 pounds, low altitude safe escape will be compromised and landing impact acceleration will increase. To assure stability of the crew module in event of ejection, it must be loaded in accordance with T.O. 1-1B-40.

CHECKLISTS.

This Flight Manual contains amplified procedures. Flight Crew Checklist T.O. 1F-111(B)A-1CL-1 is issued as a separate document.

PREFLIGHT CHECK (NUCLEAR).

Flight crew station time will normally be one hour before scheduled takeoff time. If the stores station inspection reveals a discrepancy, all physical operations will cease until qualified personnel have determined the necessary reporting and/or corrective action to be taken. The term "Qualified personnel" is defined as a nuclear weapons officer (Wing air weapons or munitions maintenance) and a nuclear safety officer.

Note

- No person will be permitted access to the aircraft with a nuclear bomb/missile installed unless escorted by the pilot or his designated representative. A minimum of two authorized persons, each capable of detecting incorrect or unauthorized procedures with respect to the task to be performed and familiar with pertinent safety and security requirements, will be present during any operations affording access to the weapon system.
- If at any time during the preflight check the possibility of sabotage exists, initiate a HELPING HAND.

BEFORE EXTERIOR INSPECTION.

1. Security guards posted. (If required)
2. Form 781—Checked.
   Pilot checks Form 781 for engineering status, discrepancies, stores configuration, and mission tape loading. He also notes fuel loading and distribution for comparison with scheduled fuel load and gages later during preflight.
3. AGM-69A Missile Status—CHECKED.
   Review status of each loaded missile. Verify that the correct prelaunch data computer program and mission data tape programs are stored. For an OTL mission, verify that an OTL mission tape is loaded. Navigator will note any variation in payload and/or operational capabilities and note exact location of each different type of missile.

EXTERIOR INSPECTION.

The exterior inspection is based upon the fact that maintenance personnel have completed all of the requirements of the Scheduled Inspection and Maintenance Requirements Manual for preflight and post flight; therefore, duplicate inspections and operational checks of systems have been eliminated except for those needed in the interest of flight safety. The flight crew should keep in mind that the exterior inspection performed by them is only a flight crew inspection of readily accessible items. Should the pilot wish information on non-accessible items, he should examine the "Preflight Inspection Record." Following the route shown in figure 2-1, check all surfaces for any type of damage; signs of fuel, oil, hydraulic or other fluid leaks that may have developed since the preflight in-

Exterior Inspection

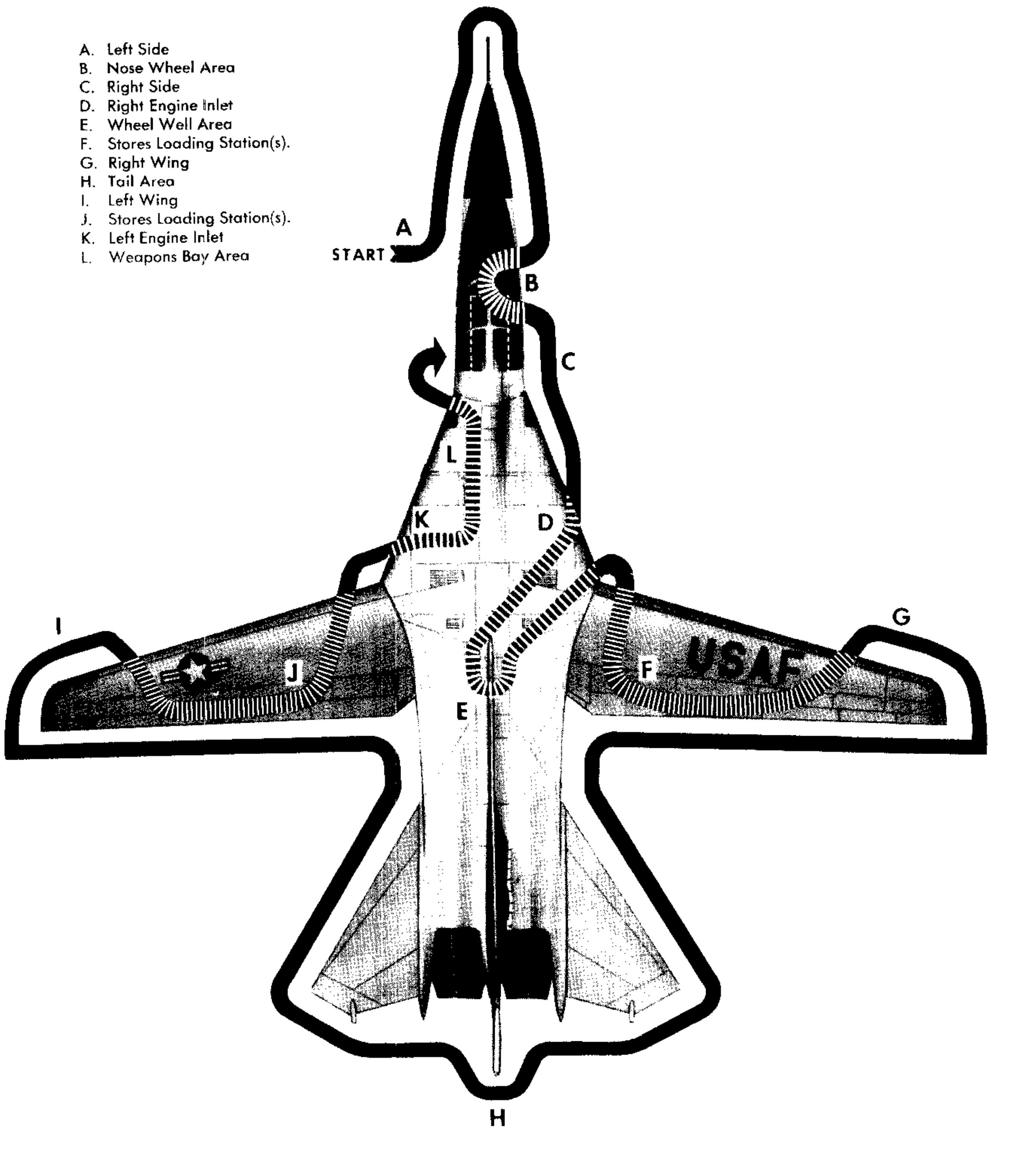


Figure 2-1.

spection. Check hydraulic accumulators. Check all access doors and covers for security. Check that gravity fuel filler caps are flush. Check the angle-of-attack and side slip probes for slot cleanliness and freedom of movement. Check main landing gear uplock assembly for proper positioning as indicated by the red tip of the lock assembly being aft of the uplock roller guide.

1. Ground safety pins and safety locks—Removed. (As required)
   Those marked with asterisk, stow in aircraft.
   *a. Nose gear
   *b. Main gear
   *c. Arresting hook
2. External fuel tank pylon ground safety pins—Removed. (Stow aboard aircraft)

Note

- For normal operations, the speed brake/main landing gear door ground lock should be left installed until one engine has been motored or started. This will prevent sagging of the door after the ground lock is removed.
- The stores station inspection and bomb/missile preflight will be accomplished concurrently with the aircraft exterior inspection.
- The landing gear emergency system may be actuated by contact with the lever-actuator located in the main wheel well on the left side. Exercise care when inspecting this area.

STORES STATION INSPECTION. (BOTH)

External Bomb/Missile Stations:

1. Bomb/missile rack ground safety pins—Installed.
2. Pivot pylon jettison ground safety lockpin — Installed, LOCKED, NUCLEAR.
   Check that the ground safety lockpin is installed, the ground lock lever reads LOCKED, and the weapon type indicator reads NUCLEAR.
3. Bomb/missile preflight—Accomplished.
4. Pivot pylon jettison ground safety lockpin—UNLOCKED, removed. (Stow aboard aircraft)
5. Bomb/missile rack ground safety pins — Removed. (Stow aboard aircraft)

Internal Bomb/Missile Stations:

WARNING

The weapons bay doors safety interlock switch will be in the SAFE position and the weapons bay door lockpin installed, before entering the weapons bay.

1. Weapons bay door interlock switch—SAFE.
2. Weapons bay door lockpin—Installed.
3. Bomb/missile rack ground safety pin—Installed.
4. Bomb/missile preflight—Accomplished.
5. Bomb/missile rack ground safety pins — Removed. (Stow aboard aircraft)

BOMB/MISSILE PREFLIGHT. (BOTH)

Note

- During bomb/missile preflight switch positions and timer settings will be verified by both aircrew members.
- Check bomb MOD number to determine PAL/non PAL status of bomb.

B-43 Bomb:

1. Ready/safe switch—"S". (SAFE)
2. Antenna radome nose cover—Removed.
3. Plenum block cover—Removed.
4. Preflight setting panel:
   a. TA and TB timer—Set. (As briefed)
   b. Retard/freefall option switch — Set. (As briefed)
   c. Preclude/ground backup option switch — Set. (As briefed)
   d. Preflight setting panel door—Closed.
5. Strike enable plug—Installed.
6. Fin protectors—Removed.
7. Explosive actuator safing assembly—Removed.

B-57 Bomb:

1. Ready/safe switch—"S". (SAFE)
2. Strike enable plug—Installed.
3. Preflight selection panel:
   a. TA and TB timer—Set. (As briefed)
   b. Top option switch—Set. (As briefed)
   c. Bottom option switch—Set. (As briefed)
   d. Burst height switch—Set. (As briefed)
   e. Preflight selection panel door—Closed.

B-61 Bomb:

1. Ready/safe switch—"S". (SAFE)
2. Preflight selection panel:
   a. TA and TB timer—Set. (As briefed)
   b. A thru F switch—Set. (As briefed)
   c. Strike enable plug—Installed.
   d. Time delay select switch—Set. (As briefed)
   e. Retard/freefall option switch—Set. (As briefed)
   f. Preflight selection panel door—Closed.

AGM-69A Missile:

1. Payload section marking—Checked.
2. OTL. C/D safing pin—Check removed.
3. SAF prearm/safe indicator—Checked "S".
4. Motor arm/disarm switch safing pin—Check removed.
5. Missile fins (internal missiles)—Checked.
6. Tail cone (external missiles)—Attached.

BEFORE ENTERING COCKPIT. (PILOT)

1. Ejection handle safety pins (2)—Installed.
2. Canopy center beam safety pins (3)—Installed.
3. Bilge pump lock pin—Stowed.
4. Emergency oxygen bottle pressure—Check, 1400 to 2500 psi.
5. All circuit breakers—In.
6. Ground check panel—Check.
   - Computer power switches (3)—ON.
   - CADC power switch—POWER.
   - Ground ignition cutoff switch—NORM.
   - Gyros power switch—GYROS.
   - Mach trim test switch—NORM.
   - Fire detect switches—NORM.
7. Publications—Checked.
8. Radio beacon set—ON or as applicable.

BEFORE ENTERING COCKPIT. (NAV)

1. Ejection handle safety pins (2)—Installed.
2. Canopy center beam safety pins (3)—Installed.
3. Survival equipment compartment covers (2)—Closed and sealed.
4. Crew module chaff dispenser control lever—As required.
   The lever should be ON over friendly territory and placed to OFF as directed by tactical requirements.
5. Quick rescue kit—Stowed. (If applicable)

INTERIOR INSPECTION.

Power Off. (Both)

Note

Aircrew members will use caution when physically verifying seals and safety wiring integrity. Use only that physical contact necessary to insure positive safing and sealing. Whenever a crewmember inadvertently breaks a seal, the following procedures will apply:

- Both aircrew members will maintain surveillance over the component involved.
- Request MMS personnel reseal the component.
- After component is resealed, advise command post of action taken.
- The known inadvertent breaking of a seal by any aircrew member does not constitute a "HELPING HAND" incident.
- To prevent missile moisture accumulation on AGM-69 missile loaded aircraft, delay supply of ground cart pneumatic pressure to the aircraft until ready to begin "Power On (Both)" checklist.

B 1. Thermal curtains—Checked, installed. (Alert acceptance only)
Check for cleanliness, general condition and proper fit, or that the curtains are safety-wired and sealed.

B 2. CSSC indicator windows—Checked "A."

Note

Cease all activity and request CSS custodians (through the command post) if any CSSC indicator window is found set other than "A."

3. Battery switch—OFF.
4. External power switch—OFF.
5. Cabin air distribution lever—Set.

B 6. Personnel equipment.
   a. Restraint harness and inertia reel—Connected and checked.
   Insure that the yoke of the restraint harness is adjusted firmly against the neck with head against headrest and sitting erect to allow full reel-in in the event of subsequent ejection. Check the condition of the restraint harness. Check operation of the inertia reel in the locked and unlocked position.
   b. Oxygen regulator—Installed.

CAUTION

Care must be taken so as not to damage valve port screens when connecting oxygen regulator to restraint harness and oxygen supply hose, or when connecting mask-hose to oxygen regulator. These screens are easily damaged by improper/careless handling, and inadvertently placing fingers on screens while performing any of the afore-mentioned tasks.

   c. Oxygen mask and communication cord—Connected.
   d. Oxygen lever—OFF, then ON.
   Turn the oxygen lever OFF and inhale several times. Note that breathing becomes more difficult due to the restrictions of the anti-suffocation valve. Also

observe that the anti-suffocation valve on the front of the regulator unseats with each inhalation, then turn the oxygen lever ON.

CAUTION

To prevent possible regulator damage, do not turn oxygen ON until dust cap has been removed from quick disconnect fitting and mask hose has been connected.

e. Oxygen regulator---Checked.
   - Oxygen control knob—EMER.
     Check that a positive pressure is felt in the mask and that the diluter valve does not move.
   - Oxygen control knob—100 percent.
     Inhale and check that the diluter valve does not move.
   - Oxygen control knob—NORM.
     Inhale and check movement of the diluter valve through the screen on the top of the regulator.

7. Air conditioning control panel:
   a. Temperature control knob—As desired.
   b. Air source selector knob—BOTH.
   c. Mode selector switch—AUTO.
   d. Pressurization selector switch—NORM.
   e. Air flow selector switch—NORM. (If installed)
   f. Exchange exit air control switch—NORM. (OVRD if external stores are installed)

B 8. Communications panel—Set.
9. Auto TF switch—OFF.
10. Control system switch—NORM.
11. Rudder authority switch—AUTO.
12. Throttles—OFF.
13. Speed brake switch—IN.
14. Anti-skid switch—ON.
15. Ground roll spoiler switch—OFF.
16. Flap/slat system selector switch—NORM.
17. Flight control disconnect switch—NORM, cover down.
18. Flight instrument reference select switch—PRI.
19. Landing/taxi lights switch—OFF.
20. Nuclear consent switch — OFF, guard down, sealed.
21. Bombing timer—OFF.
22. Landing gear handle—DOWN.
23. Utility hydraulic system isolation switch—NORM.
24. Ground jettison switch—OFF, guard down.
25. Arresting hook handle—In.
26. Clock—Set.
27. Optical display system mode select knob—MAN.
28. Aiming reticle cage lever—Uncage.
29. Radar altimeter control knob—Full CCW.
30. Engine/inlet anti-icing switch—AUTO.
31. Pitot/probe heater switch—OFF/SEC.
32. Windshield wash/rain removal selector switch—OFF.
33. AFRS compass mode selector knob—Slaved and LAT set.
34. Hemisphere selector switch—As required.
35. Emergency generator indicator/cutoff pushbutton—In and safetied.
36. Emergency generator switch—AUTO.
37. Generator switches (2)—RUN.
38. Antenna select switches—As required.
39. Landing gear emergency (alternate) release handle—IN.
40. Fuel dump switch—OFF.
41. Air refueling switch—CLOSE.
42. Fuel tank pressurization selector switch—AUTO.
43. Engine feed selector knob—OFF.
44. Fuel transfer knob—OFF.
45. TFR channel mode selector knobs (2)—OFF.
46. Spike control switches (2)—NORM.
47. UHF #2—OFF.
48. TACAN—OFF.
49. ILS power switch—OFF.

N 50. Radar transponder control panel—Checked.
   - Encode knob—As briefed.
   - Power knob—OFF.
   - Decode knob—As briefed.

N 51. UHF #1—OFF.

N 52. TFR scope panel—Checked.
   - Polaroid filter control (2)—Full up.
   - Tuning control knobs (4)—CCW.
   - Range selector knob—E.

N 53. RHAW scope controls—Checked.
   - Gate selector knob—N.
   - Brightness/reticle/intensity knob—CW.
   - Sensitivity knob—Full CW.
   - Memory control knob—Full CCW.
   - Mode selector knob—As desired.
   - View control knob—Full CCW.
   - Scope filter—As desired.

N 54. RHAW threat display panel—Checked.
   - Remaining disposable counter—Checked.
   - Test knob—OFF.
   - Power/audio control knob—OFF.

N 55. Attack radar scope panel—Checked.
- Beta switch—NORM.
- Sweep switch—NORM.
- Test switch—OFF.
- Range intensity knob—Midpoint.
- North orientation selector switch—As desired.
- Azimuth intensity knob—Midpoint.
- Bezel/range mark intensity knobs—Midpoint.
- Scope intensity knob—CCW.
- Range selector knob—15/5.
- Video/transmit tuning knobs—Midpoint.
- Sensitivity time control knobs—OFF.
- IF gain/antenna tilt knobs—Midpoint/detent.
- Photo mode selector switch—OFF.
- Magazine data slate/clock—Annotated and set.

N 56. Attack radar control panel—Checked.
- Mode selector knob—GND MAN.
- Frequency control knob—AFC-1.
- Radar function knob—OFF.
- Present position correction switch—OUT.
- Antenna polarization switch—NORM.
- Side lobe cancellation switch—OFF.
- Fast time constant/beacon switch—OFF.

N 57. Navigation display unit:
a. Fix mode selector knob—OFF.
b. Nav mode select pushbuttons—I only.

N 58. IFF master control knob—OFF.

N 59. DCU-137/A control panel:
a. Control lever—OMS, sealed.
b. Option select switch—OFF.
c. Monitor and release knob—OFF.
d. Class III command override switch—OFF.

N 60. Stores control panel:
a. Release enable switch—INHIBIT.
b. Master switch—OFF.
c. RBS tone switch—OFF.
d. Delivery mode knob—OFF.
e. Selector mode knob—OFF.
f. Bay door control switch—Checked.
Check that the position of the bay door control switch is in agreement with the position of the weapons bay doors.

WARNING

If the position of the bay door control switch is not in agreement with position of the weapons bay doors, the doors may actuate to the commanded position when hydraulic and/or electrical power is applied to the aircraft.

g. Bay door auxiliary switch—NORM.
h. Station selector switches—All deselected.

N 61. SRAM cooling switch—OFF.

N 62. AGM-69A control and display panel:
a. Power switch—N.
b. Class switch—N.
c. Missile switch—N.
d. Train switch—OFF.
e. RHAW/RDR mode switch—N.
f. ARH/INERT mode switch—INERT.
g. Select and monitor knob—OFF.
h. OTL Operational test launch switch—N. (If installed)

N 63. Computer control unit:
a. Function select knob—OFF.
b. Test selector knob—NORM.
c. Test switch—NORM.
d. General navigation computer switch—GNC.
e. Weapons delivery computer switch—WDC.
f. INS ground align knob—G/C.

N 64. HF radio mode selector knob—OFF.

N 65. CMDS control panel:
a. Arming switch—SAFE.

WARNING

Placing the arming switch and mode selector knobs to any position other than SAFE or OFF could result in inadvertent dispensing of explosive chaff and flares.

b. Mode selector knobs (3)—OFF.

N 66. ECM control knobs (3)—OFF.

N 67. IRRS control panel:
a. Function selector knob—OFF.
b. Azimuth blanking knob—AUTO.
c. Elevation blanking knob—AUTO.

Power On. (Both)

Note

- If any weapons discrepancy is noted during performance of the "Power-On" check, refer to Section III.
- When the aircraft is uncocked for maintenance/defueling, accomplish the "Exterior," "Stores Station Inspection" (starting with "Bomb/Missile Preflight"), "Interior Inspection, Power-Off," and asterisked items of the "Interior Inspection, Power-On" checks prior to recocking the aircraft.

1. Battery switch—ON.
   TIT power-off flags out of view indicates battery is on.

*2. External power switch—ON. (If applicable)
   If external power is to be used, place the external power switch ON and check that the electrical power flow indicator displays TIE.

Note

If the engines are to be started using battery power, the following "Power On" checks must be delayed until the engines are running.

*B 3. Seat and headrest—Adjusted.

*4. Circuit breakers—In.

5. Central air data computer test switch—LOW, and depress master test button and check:
   a. Angle-of-attack indexer—High speed symbol.
   b. Angle-of-attack—7.0 ($\pm$0.75) degrees.
   c. Mach number—0.4 mach.
   d. Indicated airspeed—153 ($\pm$11) KIAS, OFF flag in view.
   e. Altitude vertical velocity—($\pm$100) feet per minute.
   f. Altimeter (with 29.92 set)—2000 ($\pm$130) feet, OFF flag in view.
   g. Central air data computer true airspeed—158 ($\pm$13) TAS.
   h. CADS caution lamp—Lighted.

Note

When the CADC test switch is used in conjunction with the master test switch, the function select knob or the INS ground align knob should be in the OFF position or fluctuations of system altitude may be experienced for time periods up to 20 minutes.

6. UHF radios—ON.

CAUTION

UHF radio(s) may be turned ON, but do not transmit without cooling air on the aircraft (unless required by an emergency).

7. Lighting control panel—Checked.
   Check operation of the interior light rheostats and set for desired intensity. Check operation of bright and dim switches and select desired intensity.

B 8. Malfunction and indicator lamps and stall warning system—Check.
   - Pitot/probe heater switch—OFF/SEC.

WARNING

If pitot/probe heater switch has been in the HEAT position, residual heat in the probe may be sufficient to cause injury to ground personnel.

   - Alpha probe slots—Full up. (Lowest angle-of-attack value) (GO)
   - Malfunction and indicator lamps test button—Depress and check all malfunction and indicator lamps light, check for intermittent (landing gear) audible warning tone through headset.
   - With malfunction and indicator lamps test button depressed.
   - Warning horn silence button operation.
   - Malfunction and indicator lamps test button—Release.
   - Stall warning system—Check. (After T.O. 1F-111-891)
   - Alpha probe slots—Full down. (Highest angle-of-attack value) (GO)
   - With malfunction and indicator lamps test button depressed, check stall warning lamp flashing, steady audible warning tone through headset, and rudder pedals shaker activated.

Note

When the lamps test button is depressed, the rudder may deflect due to AYC input and the yaw channel caution lamp may light. This is normal.

   - Malfunction and indicator lamps test button—Release.
   - Check malfunction and indicator lamps for abnormal indications.

Note

When the lamps test button is released, the yaw channel caution lamp may remain lighted, in which case, reset to put lamp out.

9. Flap/slat and wing sweep handles correspond with surface position—Checked.

10. Oil quantity indicators—Checked.
    Check that indicators show 16 quarts, place the oil quantity indicator test switch to OIL

QTY and check that indicators decrease to 5 quarts on the left indicator and 5.7 quarts on the right indicator and check that the oil low lamp lights. Release test switch and check that indicators return to original readings.

11. Oxygen quantity—Checked.
    Check that oxygen quantity is adequate for mission. Place oxygen quantity test switch to OXY QTY. Oxygen quantity indicator should decrease to zero. Note that the oxygen quantity caution lamp lights when indication is 2 liters. Release the test switch and note that the caution lamp goes out and that the quantity indication returns to original value.
12. Fire detect circuit—Checked.
    - Hold the agent discharge/fire detect test switch to FIRE DETECT TEST and check that the wheel well hot caution lamp and both engine fire warning lamps are lighted. Release the switch.
    - Position the fuselage overheat test switch to LOOP 1. The wheel well hot caution lamp shall not light.
    - Position the fuselage overheat test switch to LOOP 2. The wheel well hot caution lamp shall not light.

Note

The fire detection system ground test switches (on ground check panel) should be checked for normal position.

13. Ground check panel door—Closed.
14. AFRS synchronization indicator—Nulled.
15. Engine feed selector knob—FWD, then AFT.
    Check that the appropriate fuel pump low pressure indicator lamps (six) light and go out and that the L and R FUEL PRESS caution lamps are out.

*B 16. Fuel quantity and indicators—Check.
    If forward or aft tank pointers or totalizer fails to test or all tank quantities do not add up to the total fuel indication (±1000) pounds, a malfunction is indicated.
    a. Fuel quantity—Checked.
       Check fuel quantity indications of all fuel tank gages against scheduled fuel load.
    b. Fuel quantity indicator test button—Depress and check:
       (1) Forward and aft tanks—2000 (±400) pounds.
       (2) Select tank—2000 (±100) pounds.
       (3) Total fuel—2000 (±1250) pounds.
    c. Check that forward and aft tank fuel quantity indicator pointers, totalizer, and select tank pointer move smoothly.

WARNING

If either forward or aft tank fuel quantity indicator pointers indicate a malfunction, do not fly the aircraft.

    d. Fuel distribution caution lamp—Lighted after 12 seconds.
    e. Fuel quantity indicator test button—Release.
    f. Fuel distribution caution lamp — Remains lighted for 10 to 15 seconds, then goes out.

17. Engine feed selector knob—AUTO.
    Select AUTO when the forward tank pointer is approximately 2000 pounds outside the bar index of the fuselage fuel quantity indicator.

Note

If fuel tank expansion space has been reduced due to fuel overfill or thermal expansion, some fuel venting may occur while the fuselage fuel quantity indicators are returning from the test indications if the engine feed selector knob is positioned to AUTO too soon. Fuel venting must cease prior to takeoff.

    a. Fuel distribution caution lamp—Lighted until distribution is within limits.

Note

If a malfunction is indicated in the fuel distribution system, position the engine feed selector knob to OFF to preclude possible fuel venting.

    b. Appropriate fuel pump low pressure indicator lamps—Light and go out.
    c. All indicators—Return to original indications.

18. Fuel transfer knob—AUTO.
    Hesitate at each position containing fuel and check that fuel low pressure indicator lamps blink and go out.

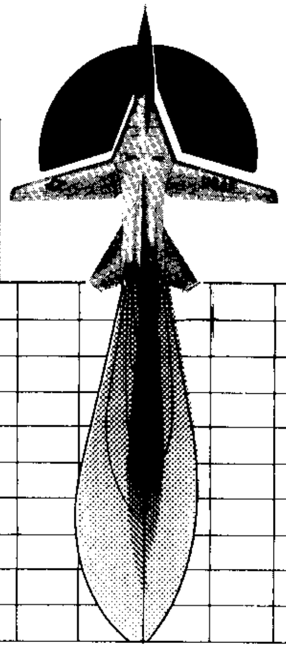
N 19. Coded switch set controller (CSSC):

Note

Cease all activity and request CSS custodians (through the command post) if the ENABLE lamp comes on at any time other than during the lamp test button check. For other abnormal indications, refer to "CSS Malfunction Analysis" Section III.

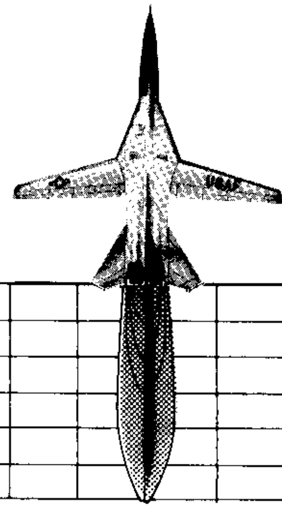
Danger Areas (Typical)

ENGINE: TF30-P-100
DATA BASIS: ESTIMATED
DATE: 4 JUNE 1971



DISTANCE FROM JET NOZZLE (FEET)	MAX AB THRUST TEMPERATURE (FAHRENHEIT)	MAX AB THRUST VELOCITY (MPH)	MILITARY THRUST TEMPERATURE (FAHRENHEIT)	MILITARY THRUST VELOCITY (MPH)
20	2000°	1750	500	1100
40	1000°	1160	300	455
60	600	410	200°	210
80				
100	400	200	150	105
120			125	70
140	300	125		
160			110	
180				
200	200	55		

JET WAKE RADIUS (FEET) 30 15 0 15 30

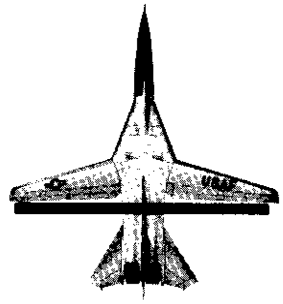


DISTANCE FROM JET NOZZLE (FEET)	IDLE THRUST TEMPERATURE (FAHRENHEIT)	IDLE THRUST VELOCITY (MPH)
30	150°	70
40		
50	125°	40
60		
70		
80		

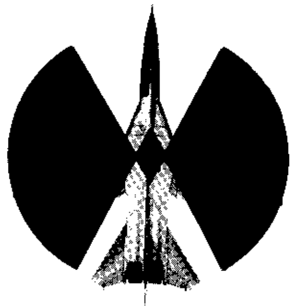
JET WAKE RADIUS (FEET) 30 15 0 15 30

WARNING

- At high thrust settings, the danger area around the intake ducts may extend as far as four feet aft of the duct lip.
- With engines operating above idle rpm ear protection should be worn due to high engine noise levels. At idle rpm do not expose unprotected ears to engine noise for periods greater than 5 minutes.



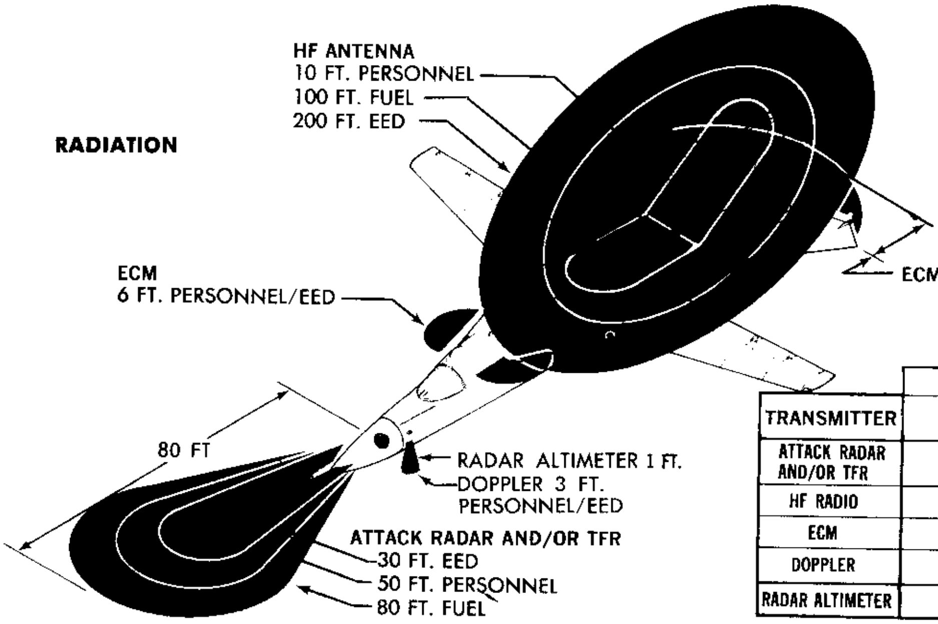
ROTATING PLANES OF ENGINE TURBINES



TIRE AVOIDANCE

If landings are made which for some reason require maximum braking to stop the aircraft, avoid tire area for 1 hour and 15 minutes after aircraft has stopped. If necessary, approach from the front or rear only. If thermal release plugs have blown allowing tires to deflate, danger of explosive failure is minimal; however, danger of fire exists for at least one hour.

RADIATION



TRANSMITTER	SAFE DISTANCE FROM ANTENNAS PERSONNEL HEALTH HAZARD	ELECTRO EXPLOSIVE DEVICES (EED)	FUEL
ATTACK RADAR AND/OR TFR	50 FT.	30 FT.	80 FT.
HF RADIO	10 FT.	200 FT.	100 FT.
ECM	6 FT.	6 FT.	---
DOPPLER	3 FT.	2 FT.	---
RADAR ALTIMETER	1 FT.	---	---

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Figure 2-2.

a. Operate/monitor switch—MON, DISEN lamp lighted.
b. Lamp test button—Depressed.
c. Sum code —Set.
d. Operate/monitor switch—OPER.
e. CODE and DISEN lamps—Lighted.
f. Operate/monitor switch—MON. (Momentarily)

Note

System status (enable/disenable) may be verified at any time by holding the operate/monitor switch in MON and observing DISEN and ENABLE lamp indication.

g. CSSC indicator windows—Set all "A"s.

*N20. Stores control panel:
a. Store present lamps—Checked.
Check that store present lamps are lighted and displaying the proper store identification at each loaded station.
b. Master switch—ON.

*N21. Computer program unit test/enable switch — ENABLE (GO).
If electrical power is interrupted, either by turning the master power switch to OFF or removing ground power, the ENABLE relay will deenergize. To reenergize, ground power must be available, the master switch ON, and the CPU Test/Enable switch momentarily actuated to ENABLE.

WARNING

During ground operation if malfunctions occur which are not specifically covered in Section III, complete the "Bomb/Missile Safety Check," Section III.

*N22. Stores control panel:
a. Selector mode knob—STA JETT.
b. Station select lamps—Out.
If any station select lamp is lighted, deselect stations.
c. Test button—Depressed.
Check station select lamps lighted for all loaded stations.
d. Selector mode knob—NUC WPN.
e. Test button—Depressed. (Bombs)
Check station select lamps lighted for all weapon loaded stations, out for all others.
f. Selector mode knob—OFF.
g. Master switch—OFF.

*N23. DCU-137/A control panel:
a. Option select switch—MON.
b. Monitor lamps (each nuclear loaded station)—Checked.
Rotate monitor and release knob to each nuclear loaded station and check lamp indications: SAFE lamp lighted, ENABLE lamp lighted (B-61 or PAL B-43/B-57 only) all other lamps out.
c. Monitor and release knob—OFF.
d. Option select switch—OFF.

BEFORE STARTING ENGINES.

Refer to figure 2-2, Danger Areas, for the extent of engine intake and exhaust hazard areas, and the engine turbine and starter turbine planes of rotation.

1. Auxiliary/parking brake handle—Pulled.

CAUTION

Do not perform this step if brakes are overheated.

2. Position lights—BRT and FLASH.
3. Weapons bay doors:
a. Lock-pin—Removed. (GO)
b. Safety switch—NORMAL. (GO)
c. Safety panel cover—Closed. (GO)
4. Type start—Pneumatic/cartridge.
Confirm type of start with ground observer.
5. Ground crew report—Ready for engine start. (GO)
Fire guard posted, engine run area clear, chocks in place, both entrance ladders closed and latched with slot and indices lined up, and report ready for engine start.

WARNING

The slotted head on the entrance ladder release button must be aligned with indices on either side of the button to be assured that the ladder is latched in stowed position. Failure to do so could result in the ladder being blown into the engine inlet should it extend.

DEFINITIONS.

Hot Start—TIT exceed 710 degrees C.

If during start TIT increases at an abnormally rapid rate or approaches 655 degrees C and is still climbing, a hot start can be expected.

False or Hung Start—TIT increases but rpm will not increase to IDLE within 2 minutes.

Failure to Start—Engine does not light-up within 20 seconds after throttle is positioned to IDLE. If TIT does not rise or rpm does not increase above maximum starter output, a light-up has not been obtained.

Cartridge Start Misfire—Cartridge fails to ignite as indicated by lack of smoke at the starter exhaust port. There will be no engine rpm indication.

Cartridge Start Hangfire—Cartridge ignites as indicated by smoke at the starter exhaust port; however there will be little or no rpm indication.

If any of the above conditions occur return the throttle to OFF. Crew will record magnitude, duration, and other pertinent information to aid maintenance investigation of the malfunction.

The engine should be inspected for residual fuel before a second start is attempted. If no fuel is visible a second start may be attempted. The engine should be motored until TIT is below 100 degrees C before advancing the throttle to minimize the possibility of a hot start.

If visible fuel or vapors are found the engine must be cleared using the pneumatic starter as follows:

ENGINE CLEARING.

- Engine ground start switch—PNEU.
- Affected engine throttle—Lift.

  Lift the throttle of the affected engine out of the OFF detent to motor the engine. This may be accomplished any time the engine rpm is below 20 percent.

CAUTION

To avoid a possible hot start do not advance the throttle.

- Affected engine throttle—Release.

  Release the throttle to OFF prior to the time limit specified for starter operation in Section V.

STARTING ENGINES.

Engine starts can be accomplished by using air pressure from a ground source or by a pyrotechnic cartridge. Only the left engine has cartridge starting capability. Either engine may be started by the use of external air when supplied by an adequate source; however, under some combinations of ambient temperature extremes and starter cart output variations, left engine starting capability may be marginal. For normal flight operations, it is recommended that the left engine be started first. This sequence will provide positive indications of starter dropout on both engines (right engine only after T.O. 1F-111(B)A-650). With either engine operating, the remaining engine may be started by pneumatic crossbleed; however, this is necessary only during a cartridge start when no external air source is available, or when starting the right engine first because of marginal aircart capability. Electrical power required for engine starting may be supplied by either the aircraft battery or by an external source.

WARNING

- Do not attempt a pneumatic start or fly the aircraft with an unfired cartridge in the breech. Abnormal cartridge conditions of an explosive nature could be generated due to the combination of vibration and high temperatures that can exist in the engine nacelle.
- Do not initiate a cartridge start with any nacelle door open on the engine being started. To do so could result in possible overheating of adjacent structure and/or ignition of accumulated fuel and oil.

CAUTION

- If engine has had insufficient time to cool from a previous operation, do not attempt a restart until TIT is below 100 degrees C. Motoring of the engine will reduce the temperature.
- If hydraulic cooling ejector air is not present, do not advance throttle above IDLE.
- Insure that pivot pylon jettison ground safety lockpin and bomb/missile rack ground safety pin streamers are not hanging within the danger area around the inlet ducts if pins are left in place during engine run.

1. Engine ground start switch—PNEU or CARTRIDGE. (As applicable)

2. Applicable engine throttle—Lift to start position.
   a. On a cartridge start advance the throttle to IDLE immediately.
   b. Oil pressure—Checked.

Note

- Oil pressure should be indicated within 10 seconds after first indication of rpm.
- During second engine start, check that the engine ground start switch moves to OFF prior to reaching 50 percent engine rpm. Cooling air will not be available if the switch is in any position other than OFF.
- Starter dropout is normally indicated by the hydraulic low pressure caution lamps going out at 38 to 41 percent rpm on the left engine (except after T.O. 1F-111(B)A-650), and when the engine ground start switch moves to OFF for the right engine.

WARNING

In the event of aborted start during a cartridge start due to misfire, hangfire, or slow burning cartridge, the breech will not be opened until a time period of 5 minutes has elapsed after attempted start and no smoke can be observed emitting from the starter exhaust.

3. Engine throttle—IDLE.
   On a pneumatic start advance the throttle to IDLE after the engine rpm reaches 17 percent.

Note

TIT rise should occur within 20 seconds after throttle advance.

4. Engine instruments—Check.
   a. Fuel flow—1100 pph max.
   b. TIT indicator—710 degrees C max.
   c. Idle rpm—58 to 71 percent.
   d. Hydraulic pressure indicators—2950-3250 psi, caution lamps out.
   e. Idle oil pressure—30 to 50 psi.
   f. Nozzle position—Open.
5. Engine overspeed caution lamp—Out.
6. Generator switch—START (pause), then release to RUN, check caution lamp out.

Note

If the generator caution lamp remains lighted, place the switch to OFF/RESET, hold to START (pause), then release to RUN.

7. Power flow indicator—TIE or NORM. (As applicable).
8. Hydraulic cooling ejector airflow—Check. (GO)
   After engine has been started, check that the engine ground start switch is in OFF so that the ground observer can check for cooling ejector airflow.
9. Speed brake ground lock—Removed.
10. External power switch—OFF.
11. Start remaining engine—Repeat steps 1 thru 8.

Note

Obtain ground clearance prior to advancing throttle to 80-85 percent for crossbleed starts.

12. External air conditioning, starter air and electrical power unit—Disconnected. (GO)
13. Engine ground start switch—OFF.
14. Power flow indicator—NORM.
15. Emergency generator switch—TEST, ON, then AUTO.
    Place the emergency generator switch to TEST. The emergency generator indicator lamp will light after 1 second indicating that the emergency generator is operating within limits. The power flow indicator should display a crosshatch. Check operation of T/R units by noting that the angle-of-attack indexers and ODS reticle lamps are lighted. Place the emergency generator switch to ON, check power flow indicator displays NORM. Place the emergency generator switch to AUTO. Check that indicator lamp goes out and that the power flow indicator displays NORM.

Note

If battery power was utilized for engine start complete the "Power On" checks prior to proceeding to the next checklist.

AFTER ENGINE START.

"After Engine Start" checklists may be accomplished simultaneously.

PILOT.

1. TFR mode selector knobs (2)—STBY.
2. ILS and TACAN—On and set.
3. Radar altimeter—On, cleared. (GO)
   Set 80 feet.
4. Wing sweep—Set for takeoff.
5. Wing sweep handle lockout controls—ON.
6. Flight controls clear—Cleared. (GO)
7. Flight control and damper system—Check.

Note

During the following checks, the required flight control surface positions will be verified by the control surface position indicator or the ground observer.

   a. Slats—Extended.
   b. Takeoff trim—Set.
   c. Damper switches (3)—OFF.
      Place the pitch and roll autopilot/damper and yaw damper switches to OFF and check that the pitch, roll, and yaw damper caution lamps light.
   d. Flight controls—Checked.
      - Move the control stick aft, then left wing down, right wing down: check for freedom of movement and verify that the control surfaces and surface position indicators correspond with control stick movement. Check that pitch and roll channel caution lamps do not light.
      - Move the control stick full forward, then rapidly full left through the detent to the forward left corner and hold firmly for one second. Verify that the right horizontal stabilizer indicates 12 to 18 degrees down while the stick is held in this extreme position.
      - Move the control stick rapidly full right through the detent to the forward right corner, firmly holding forward pressure. Verify that the left horizontal stabilizer indicates 12 to 18 degrees down while the stick is firmly held for one second in this extreme position, then release.
      - Rudder pedals—Check for more than 25 degrees of rudder in each direction.
   e. Damper switches (3)—DAMPER.
   f. Damper reset button — Momentarily depressed. (If necessary.)
      Check that the pitch, roll and yaw damper caution lamps go out.
   g. Trim—Checked. (Optional)
      Move auxiliary pitch trim switch to OFF, actuate stick trim button to NOSE DOWN and NOSE UP and check for no movement of stabilizers. Move auxiliary pitch trim switch to NOSE DN, then NOSE UP; check control surfaces travel in response to switch positions. Move auxiliary pitch trim switch to STICK and check trim button NOSE DOWN, NOSE UP, RWD, LWD, and rudder trim left and right, check control surfaces give proper response to trim inputs. Leave control surfaces out of center for subsequent check of takeoff trim system.
8. Flaps/slats—Retracted.

Note

When the control system switch is in NORM and the slats are retracted, a small oscillation may occur in the horizontal stabilizers which will be transmitted through the airframe. This condition is normal and will disappear when the slats are extended.

9. Series trim—Check.
   - Takeoff trim—Set.
   - Trim nose up for one second.
   - Wait for the horizontal stabilizers to stop driving at more than 8 degrees trailing edge up before completing the next step.
10. Auto TF switch—AUTO TF.
    The control stick shall drive slightly forward, the TF fly up off caution lamp shall light and the reference not engaged lamp shall light. These checks are valid whether TF is operational or not.

CAUTION

Do not initiate the next step unless both stabilizers indicate more than 8 degrees trailing edge up. If necessary, place the auto TF switch to OFF and repeat "Series Trim" checks.

11. Surface motion test—Complete.
    - Stability augmentation test switch—SURFACE MOTION, and hold until next step is completed.
    - Flight control master test button—Depress and hold for the following checks:
      - Rudder moves to right, then to the left.
      - Left horizontal stabilizer drives to near zero degrees.
      - Right horizontal stabilizer drives to approximately 10 degrees down.

- Control system caution lamps do not light.
- Flight control master test button—Release.
  - Rudder returns to neutral.
  - Both horizontal stabilizers may drift together in pitch.

12. Surface motion and light test—Complete.
    - Stability augmentation test switch—SURFACE MOTION & LIGHTS and hold until next step is completed.

CAUTION

Do not initiate the next step unless the horizontal stabilizers are more than 8 degrees trailing edge up. If necessary, place the auto TF switch to OFF and repeat "Series Trim" checks.

- Flight control master test button—Depress and hold for the following checks:
  - Rudder initially drives right then returns to neutral.
  - Left horizontal stabilizer drives to near zero degrees.
  - Right horizontal stabilizer drives to approximately 10 degrees down.
  - Pitch, roll and yaw damper, channel, and pitch and roll gain changer caution lamps light (8).
- Flight control master test button—Release.
  - Rudder initially drives left then returns to neutral.
  - Both horizontal stabilizers may drift together in pitch.

Note

If all the lamps do not light, cycle the control system switch to T.O. & LAND and return to NORM, then repeat the "Surface Motion and Light Test" checks. If all lamps still do not light, a malfunction is indicated and correction will be required before flight.

13. Damper reset button—Depress momentarily.
14. Auto TF switch—OFF.
15. All caution lamps—Out.
16. Flap/slat handle—Set for takeoff.
17. Spoiler monitor test—Checked.
    - Flight control master test button—Depress and hold.
    - Spoiler test switch—OUTBD and hold until:
      - Outboard spoilers momentarily extend, then retract.
      - Spoiler caution lamp lights.
    - Spoiler reset button—Depress.
      Check spoiler lamp out.
    - Spoiler test switch—INBD and hold until:
      - Inboard spoilers momentarily extend, then retract.
      - Spoiler caution lamp lights.
    - Flight control master test button—Release.
    - Spoiler reset button—Depress.
      Check spoiler caution lamp out.
18. Ground roll spoilers/throttles—Check.
    - Ground roll spoiler switch—BRAKE.
      Check all spoilers extend.
    - Left throttle—Advance slightly, then IDLE.
      Check all spoilers retract, then extend.
    - Right throttle—Advance slightly, then IDLE.
      Check all spoilers retract, then extend.
    - Ground roll spoiler switch—OFF.
      Check all spoilers retract.
19. UHF, TACAN and ILS radios—Checked.
    Obtain altimeter setting and runway temperature from tower.
20. EPR/nozzle—Checked, set.
21. Autopilot—Checked.
    - Prior to T.O. 1F-111(B)A-593:
      - Pitch and roll autopilot/damper switches—AUTOPILOT.
        Control stick motion may occur.
      - Control stick steering—Checked.
        Move control stick and check that reference not engaged caution lamp lights. Lamp will go out when stick is returned to neutral.
      - Altitude hold and constant track switches—Engaged.
        Reference not engaged caution lamp lights.
      - Reference engage button—Depressed.
        Reference not engaged caution lamp goes out.
      - Move stick, then release.
        Reference not engaged caution lamp lights.
      - Reference engage button—Depressed.
        Reference not engaged caution lamp goes out.
      - Autopilot release lever—Depressed.
        Check that the roll and pitch autopilot/damper switches go to DAMPER and that the altitude/mach hold and constant track/heading nav selector switches go to OFF.
    - After T.O. 1F-111(B)A-593:
      - Pitch and roll autopilot/damper switches—AUTOPILOT.
        Control stick motion may occur.
      - Altitude hold and constant track switches—Engaged.

- Autopilot release/PCSS lever—Depressed to second detent.

  Check that roll and pitch autopilot/damper switches go to DAMPER and that the altitude/mach hold and constant track/heading nav selector switches go to OFF.

22. Radar altimeter—Checked.

    Depress and hold radar altimeter control knob, check for an indication of 95 (±12) feet prior to T.O. 1F-111-996 or 300 (±15) feet after T.O. 1F-111-996 and that radar altitude low lamp goes out. Select another channel and repeat test.

23. ISC—As desired.
24. Takeoff trim—Set, confirmed. (GO)
25. TFR operational check: (Prior to T.O. 1F-111-996)

WARNING

Do not transmit with the TFR if personnel or equipment are within the dangerous radar emission area. See Figure 2-2.

Note

- If time prohibits pilot accomplishing this check on the ground, both crew members must accomplish inflight prior to TF operation.
- This check must be accomplished on the ground or above low altitude radar altimeter range (5000 feet absolute) to obtain proper light indications.
- When switching channels, or changing clearance plane settings, a momentary TF fail and fly-up maneuver may occur. Prior to T.O. 1F-111(B)A-593, the autopilot release lever can be held depressed to prevent the fly-up maneuver from occurring. After T.O. 1F-111(B)A-593, the autopilot release/pitch control stick steering lever can be held depressed to the first detent to prevent the fly-up maneuver from occurring.
- The flight vector caution lamp will be lighted until the INS is partially aligned.

a. Antenna cage pushbutton indicator lamp—Out.

b. TF, SIT, and GM mode check—Complete.

Note

- If, on the ground, the TF warning lamps stay lighted, check angle-of-attack indicator. If the reading is not in the range of plus 2 to plus 6 degrees, moving probe into this range will put the lamps out.
- After T.O. 1F-111(B)A-651, the velocity caution lamp will be lighted during ground checks.

(1) TFR channel mode selector knobs—L TF, R SIT.

(a) Channel fail caution lamp—Lighted. The Channel Fail Caution Lamp of the channel in TF should be ON, and the lamp of the channel in SIT should be OFF.

(b) Reference or ATF not engaged caution lamp (as applicable)—Lighted.

(c) TF fly-up off caution lamp—Lighted.

(d) TF fail warning lamp—Lighted.

(2) ISC pitch steering mode switch—TF. The ISC must be in a mode other than ILS, AILA, or TKR RV.

(3) ADI/ODS pitch steering bars—Full up.

(4) Radar altimeter bypass switch—BYPASS. If check is performed on the ground the switch must be held in the bypass position.

(a) Check TFR channel fail caution lamps—Out.

(b) Check TF fail warning lamp—Out.

(c) TF fly-up off caution lamp—Out.

(d) Reference not engaged caution lamp—Lighted.

(e) ADI/ODS pitch steering bars—Dive.

(5) Radar altimeter bypass switch—Release to NORMAL. (Ground check only) Any time the aircraft is below 5000 with radar altimeter operating, this switch will automatically release to normal.

(6) E scope—Checked. Adjust the contrast control until a thin vertical line along the right side of the E scan is discernible. Adjust the memory control knob so the sweep is repainted just prior to the fade point. Set the video knob to midpoint (adjust for optimum target display when at low altitude).

(7) Self test pulse—Checked.
Check for the presence of a test pulse.

(8) Zero command line—Check.

(a) Ride control knob—Checked.
Rotate thru each position. Check the zero command line position for proper movement and a smooth curve for the three ride settings.

(b) Terrain clearance knob—Checked.
Rotate thru each position. Check the zero command line position for proper movement and a smooth curve for all clearance settings.

(9) SIT and GM check—Checked.
Rotate range selector knob from E to 5, checking for following indications: In 15 mile position, scope should show 15 mile range with three cursors evenly spaced. Check 10 and 5 for proper range and five evenly spaced range cursors. Switch to GM and check antenna tilt in 5 NM range. Return range selector knob to E and check range and cursors in GM 5, 10, and 15 as above.

c. TFR channel mode selector knobs—STBY.

d. Radar altimeter channel selector switch—Opposite channel.

e. Repeat TF, SIT, and GM mode check with TFR and radar altimeter channels reversed.

25A. TFR Operational Check: (After T.O. 1F-111-996)

WARNING

Do not transmit with the TFR if personnel or equipment are within the dangerous radar emission area. See figure 2-2.

Note

- If time prohibits pilot accomplishing this check on the ground, both crew members must accomplish "TFR Inflight Operational Check," Section IV prior to TF operation.
- This check must be accomplished on the ground to obtain proper lamp indications.
- When switching channels or changing clearance plane settings, a momentary TF fail may occur.
- The flight vector caution lamp will be lighted until the INS is partially aligned.

a. Antenna cage pushbutton indicator lamp — Out.

b. TF, SIT, and GM mode check—Complete.

Note

- If, on the ground, the TF warning lamps stay lighted, check angle-of-attack indicator. If the reading is not in the range of plus 2 to plus 6 degrees, moving probe into this range will put the lamps out.
- After T.O. 1F-111(B)A-651, the velocity caution lamp will be lighted during ground checks.

(1) Terrain clearance knob—Set 300 feet.

(2) Radar altimeter index pointer—Set 100 feet.

(3) TFR channel mode selector knobs — L TF, R SIT.

(a) Channel fail caution lamp—Lighted.
The channel fail caution lamp of the channel in TF should be lighted, and the lamp of the channel in SIT should be out.

(b) Reference or ATF not engaged caution lamp (as applicable)—Lighted.

(c) TF fly-up off caution lamp—Lighted.

(d) TF fail warning lamp—Lighted.

(e) Radar altitude low warning lamp—Lighted.

(4) ISC pitch steering mode switch—TF.

(5) Radar altimeter control knob — Depress and hold.

(a) Radar altimeter—300 (±15) feet.

(b) Radar altitude low warning lamp—Out.

(c) TF failure warning lamp—Out.

(d) TFR channel fail caution lamps — Out.

(e) TF fly-up off caution lamp—Out.

(6) Radar altimeter bypass switch — BYPASS and hold.

(a) TF failure warning lamp—Lighted.

(b) Radar altitude low warning lamp—Lighted.

(c) TFR channel fail caution lamps — Lighted.

(d) TF fly-up off caution lamp—Out.

(e) Pitch steering bar and aural command will indicate a maximum climb command.

Note

The pitch steering bar and aural command may be indicating a climb command due to the presence of forward video. However, the induced fail condition of this test will provide a maximum climb indication for both the manual and aural command devices.

(7) Radar altimeter bypass switch—Release to NORMAL.
 (a) TF failure warning lamp—Out.
 (b) Radar altitude low warning lamp—Out.
 (c) TFR channel fail caution lamps—Out.
(8) Terrain clearance knob—Set 400 feet.
 (a) TF failure warning lamp—Lighted.
 (b) Radar altitude low warning lamp—Lighted.
 (c) TFR channel fail caution lamp—Lighted, for channel in TF mode.
 (d) Pitch steering bar and aural command will indicate a maximum climb command.
(9) Radar altimeter control knob—Release.
(10) E scope—Checked.
 Adjust the contrast control until a thin vertical line along the right side of the E scan is discernible. Adjust the memory control knob so the sweep is repainted just prior to the fade point. Set the video knob to midpoint (adjust for optimum target display when at low altitude).
(11) Self-test pulse—Checked.
 Check for the presence of a test pulse.
(12) Zero command line—Check.
 (a) Ride control knob—Checked.
  Rotate thru each position. Check the zero command line position

for proper movement and a smooth curve for the three ride settings.

(b) Terrain clearance knob—Checked.
Rotate thru each position. Check the zero command line position for proper movement and a smooth curve for all clearance settings.

(13) SIT and GM check—Checked.
Rotate the range selector knob from E to 5, checking for following indications: In 15 mile position, scope should show 15 mile range with three cursors evenly spaced. Check 10 and 5 for proper range and 5 evenly spaced range cursors. Switch to GM and check for antenna tilt in 5 NM range. Return range selector knob to E and check range and cursors in GM 5, 10, and 15 as above.

c. TFR channel mode selector knobs—STBY.

d. Radar altimeter channel selector switch — Opposite channel.

e. Repeat TF, SIT, and GM mode check with TFR and radar altimeter channels reversed.

26. Pitot heat—Checked (GO), then OFF/SEC.
Turn pitot/probe heater switch to HEAT and have ground crewman check probes for operation.

WARNING

Do not place pitot/probe heater switch to HEAT until ground crewman is ready to check the pitot probes, otherwise overheating may result with possible injury to ground crewman.

NAVIGATOR.

This checklist may be accomplished any time power and air conditioning are available.

1. Function select knob—GND ALIGN.
Check that the INS heat lamp comes on immediately after entering ground align mode. The align lamp should light within 90 seconds after going to the ground align mode. Alignment is complete when the align lamp starts flashing.

Note

If only one computer and the INS are powered up simultaneously, the computer will halt.

2. RHAW power/audio control knob—Midpoint.
3. Radar function knob—STBY.
4. Data entry:
   a. Data switch—ENTRY.
   b. Data number—Enter 00.
   c. Latitude/longitude—Enter to nearest .01.
   d. Magnetic variation—Enter to nearest .1.

Note

Data cannot be entered into the computers if the ALT CAL pushbutton was depressed when the DCC was powered up.

5. INS reset button—Depress momentarily.
If the align lamp is lighted, it will go out for one second after the INS reset button has been depressed.
6. Doppler radar pushbutton—Depressed, light on.
7. Astrocompass pushbutton — Depressed, lamp lighted.
8. Astrocompass:
   a. GHA of Aries—Enter to nearest .01.
   Depress (ENT) pushbutton at the time of selected GHA.
   b. Star altitude error/heading difference display—Checked.
   Check that the star altitude error/heading difference display is lighted and the astro compass is searching.

Note

Any momentary power interruption such as switching from external to aircraft power necessitates reentering GHA of Aries. If the star lost lamp is on when GHA of Aries is reentered, depress the star advance pushbutton after GHA of Aries reentry.

9. Horizontal situation display (HSD) data entry: (If applicable).
   a. Data switch—ENTRY.
   b. Address select switch—Data number. (201-250)
   c. Sequence number setwheels—Set to 00.
   d. Address select switch—LAT.
   Enter reference latitude.
   e. Address select switch—LONG.
   Enter reference longitude.
   f. Address select switch—ELEV/RMAP.
   Enter map radius (inches).
   g. Sequence number setwheels—Set to 01.
   h. Address select switch—LAT for Lambert Conformal or LONG for Mercator.
   i. Data entry pushbuttons—Enter central LAT or LONG.

10. RHAW system—Checked.
    a. Power/audio control knob—As desired.
    b. Sensitivity knob—As desired.
    c. Memory control knob—As desired. Normally fully counterclockwise.
    d. Brightness/reticle intensity knob — As desired.
11. Attack radar—ON, tuned.
    Tune the radar for proper scope sweep, cursors, and range marks. The radar function knob will be placed to XMIT only during alert aircraft acceptance.

WARNING

- Do not place radar function knob to transmit if personnel or equipment are within the dangerous radar emission area. See figure 2-2.

12. Mode selector knob—GND AUTO.
13. IFF—STBY and set.
14. IRRS function selector knob—STBY.
15. Sequence number verification—Accomplished as desired.
16. Weapon location and identification verification—Accomplished as desired.
17. Recording camera—Checked.
    Place the photo mode selector switch to AUTO and check for proper operation, then place the switch to OFF. (Use of narrow sector will decrease the time required to complete check.)

BEFORE TAXIING. (NAV READS)

B 1. Altimeters—Set.

WARNING

Do not push in on standby altimeter set knob when setting barometric pressure as disengagement of the gear train between the indicating pointers and the barometric scale may occur, resulting in erroneous altimeter readings. Observe that the pointers and barometric scale move simultaneously with set knob rotation.

B 2. Ejection handle and center beam safety pins—Remove, display to ground crew, and stow.

3. Weapons bay doors:
    a. Weapons bay doors—Clear. (GO)
    b. Weapons bay door control switch—CLOSE.
    c. Report weapons bay doors closed — Confirmed. (GO)
4. Air refueling receptacle — Confirmed closed. (GO)
5. Remove ground wire, interphone and chocks—Removing ground wire, interphone, and chocks, taxi on my signal. (GO)

N 6. Nav mode select pushbuttons—Check I selected.

N 7. Function select knob—NAV.
    Placing the function select knob to NAV prior to obtaining a flashing align lamp can result in reduced INS accuracy.

8. Ready to taxi. (GO)
    Pilot will signal with steady taxi light for ground observers to clear aircraft for taxiing. Flashing taxi light will notify crew chief to re-establish interphone communications.

Note

For normal training missions proceed with "Taxiing" checklist. If aircraft is to be placed on alert proceed with "Cocking" checklist.

TAXIING. (NAV READS)

Note

For "Turning Radius" during taxi operations, see figure 2-3.

TAXIING WITH WINGS AT 16-26 DEGREES.

73L ANTI-COLLISION LT - ON

1A Auxiliary/parking brake handle—In.

2. Nose wheel steering—Engaged.
    Check that the nose wheel steering indicator lamp is on. Check engagement of nose wheel steering by slight movement of rudder pedals.

Note

Full nose wheel steering will not be available when slats are retracted and the flight control switch is in NORM. If full rudder authority is desired, place the rudder authority switch to FULL. Use of the T.O. & LAND position is not recommended. If turn radius is exceeded, range switch will automatically disengage controlled steering from rudder pedals and NWS/AR lamp will go out.

Turning Radius

BASED ON:
- To Maximum Gross Weight
- Minimum Taxi Speed (Not to Exceed 5 Knots)
- 40 Degrees Nose Steering

NOTE:
*For Every 10 Knots Increase in Speed Up to Maximum Taxi Speed, Approximately 100 Feet Increase in Turn Radius is Required.
*Measured to Aircraft C.G.

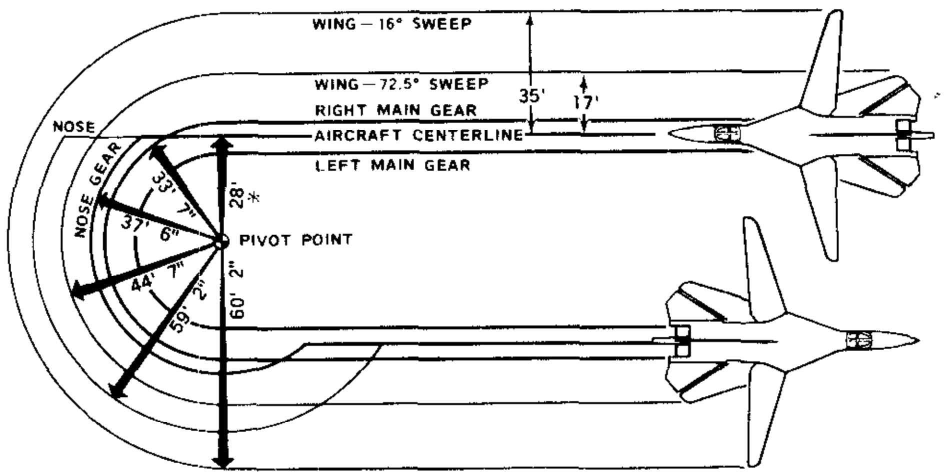

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Figure 2-3.

3. Hydraulic pressure—Checked.
   Check for 2950 to 3250 psi indication.
4. Brakes—Checked.
   Depress brake pedals and check for proper braking.
5. Flight instruments—Checked.
   Check the flight instruments for proper operation during taxi.

TAXIING WITH WINGS AFT OF 26 DEGREES.

1. Flap/slat handle—UP.
2. Wing sweep handle lockout controls—Checked.

CAUTION

If fixed stores or multiple weapon racks are being carried, place the appropriate lockout control to ON to prevent sweeping stores into the fuselage and/or prevent store-to-store contact.

3. Wing sweep handle—As required.

CAUTION

At light gross weights or with external stores, sweeping the wings full aft may establish an aft center of gravity condition, resulting in full nose strut extension and free castering of the nose wheel.

4. Nose strut extension—Checked. (GO)
5. Rudder authority switch—FULL. (Confirm)
6. Perform the steps under "Taxiing with Wings at 16-26 Degrees," this section.

BEFORE TAKEOFF. (NAV READS)

1. Wings, flaps, and slats—Set for takeoff.
   Check the surface position indicator for selected wing, flap, and slat settings.
2. Ground roll spoiler switch—BRAKE.
3. Speed brake switch—IN.
4. Anti-skid switch—ON, caution lamp out.
5. Control system switch—NORM.
6. Rudder authority switch—AUTO.
7. Takeoff trim—Checked.

WARNING

A malfunction is indicated if the takeoff trim indicator lamp does not light immediately after takeoff trim button is depressed.

8. Engine/inlet and anti-icing switch—AUTO.

B 9. Fuel quantity and fuel distribution—Checked.

~~N 10. Anti-collision light—On.~~

73-6 ~~Turn anti-collision lights on and position lights to BRIGHT and STEADY.~~

N 11. Automatic sequencing—Initiated.
- Sequence number setwheels—First destination.
- Destination pushbutton—Depress.
- Sequence number select pushbutton—Depress.

B 12. Flight instruments and radios—Set for takeoff.
Command mach, airspeed, and altitude digital readouts should be set to meaningful values that are coordinated and understood by both crew members.

WARNING

Do not take off if the airspeed mach indicator reads greater than mach 0.42. An erroneous CADC output can result in improper mach trim functions of the engine fuel control unit causing a significant reduction in engine thrust (as much as 40 percent) on both engines, when the landing gear handle is placed to UP after takeoff. In the event of a sudden thrust reduction when the landing gear handle is placed to UP, with an accompanying abnormal mach indication, recover normal thrust by returning the landing gear handle to DN and land as soon as practicable.

N 13. Altitude calibration—Complete. (If desired)

B 14. Canopy hatches—Closed and latched, unlock warning lamp out.

B 15. Canopy latch handle lock tab—Flush.
Snap the spring-loaded latch handle lock tab into the locked (flush) position and pull on the latch handle to check that it is locked.

B 16. Warning and caution lamps—Checked.
Check that all warning lamps are out and that caution lamps are compatible with mission.

N 17. Radar transponder—As required.

B 18. Oxygen—As required.

B 19. Takeoff data—Checked.

20. Nuclear caution lamp—OFF.

N 21. IFF master control knob—As required.

22. Pitot/probe heater switch—HEAT.

N 23. Radar function knob—As desired.

24. Ground jettison switch—ARM.

WARNING

Prior to placing the ground jettison switch to ARM, insure that immediate area is clear of personnel, other aircraft and equipment.

Note

Bombs/missiles without nuclear warheads installed are considered non-nuclear stores for purposes of emergency jettison. Accomplish steps 24 and 25 for bombs/missiles without nuclear warheads.

N 25. Station select switches (all external bombs/missiles)—Selected.

26. Nuclear consent switch—Rel only.

B 27. Lower helmet visor—As practical.

Note

Whenever practical the flight crew shall lower helmet visors for protection against birds strikes which might cause windshield failure when flying at low levels.

TAKEOFF.

CAUTION

Failure of the engine nozzle to close when throttle is advanced to slightly above IDLE or nozzle failure in the open position will result in engine overspeed if throttle is advanced to a higher power setting.

1. Throttles—MIL.
2. Brakes—Release.
3. Throttles—MAX AB.
4. Engine instruments—Checked.

NORMAL TAKEOFF.

Normal takeoffs will be accomplished with wings positioned at 16 degrees and 25 degrees flaps. The recommended flap setting provides an optimum trade off between single engine rate of climb at takeoff speed and ground roll. It is recommended that maximum afterburner thrust be used for all normal takeoffs. Asymmetric afterburner operation presents no directional control problem and can easily be controlled with nose wheel steering or rudder as required. Takeoffs may be made from a standing or rolling start.

1. For standing start takeoffs, hold the brakes and advance throttles to MIL. When engines are stabilized at MIL, release brakes and smoothly advance throttle to MAX AB power. The engine instruments check should be made as soon as possible after reaching full maximum afterburner power.
2. For rolling start takeoffs, the takeoff check should be started as the aircraft becomes aligned with the runway. The engine instrument check should be made as soon as possible after reaching full maximum AB power.

Nose wheel steering should be used during the takeoff roll and should be disengaged at 80 knots (rudder becomes effective at 50 to 70 knots), since rudder displacement necessary for directional steering may be excessive for nose wheel steering. The aircraft instruments must be monitored closely to assure normal aircraft performance and operation. Particular attention must be paid to the nozzle position and EPR indicators to assure thrust requirements are at acceptable levels. Crosscheck airspeed indicators for proper operation. Decision (S1) speed is used as the decision point for either aborting or continuing the takeoff. The takeoff will be continued if aircraft operation is normal; otherwise the takeoff will be aborted. (Refer to T.O. 1F-111(B)A-1-1 for takeoff data computations.) At 15 knots below takeoff speed initiate back stick pressure to achieve at rotation rate that will result in a takeoff attitude at the recommended takeoff speed. Rotate the aircraft smoothly to takeoff attitude and avoid abrupt stick inputs (especially at light gross weights) that would result in rapid strut extension of the main landing gear at liftoff.

CAUTION

Abrupt stick inputs to rotate the aircraft will produce rapid rotation and liftoff, and may cause excessive loads to be applied to the main landing gear structure, possibly resulting in damage to the gear.

Adequate longitudinal control may be available to lift the nose wheel from the runway at lower speeds but it is recommended that this not be done since it will lengthen the takeoff distance slightly due to increased drag.

Note

- Rotational characteristics of the aircraft will vary with gross weight, center-of-gravity position and external stores loading. Certain combinations (light gross weight and/or aft center-of-gravity location) will result in a fairly rapid rotation when aft stick force is applied. With a heavy aircraft and/or a forward center-of-gravity location, immediate rotation may not occur with aft stick movement and a much slower rate of rotation may be experienced. In some cases, takeoff attitude may not be achieved until takeoff speed is reached. Therefore, takeoff should not be aborted due to failure to rotate until takeoff speed is attained.
- If obstacle clearance is required, aircraft pitch attitude should be increased after takeoff to 15 degrees (not to exceed 13 degrees angle-of-attack). Do no retract flaps or slats until the obstacle has been cleared, pitch attitude reduced, and angle-of-attack is within recommended limits.

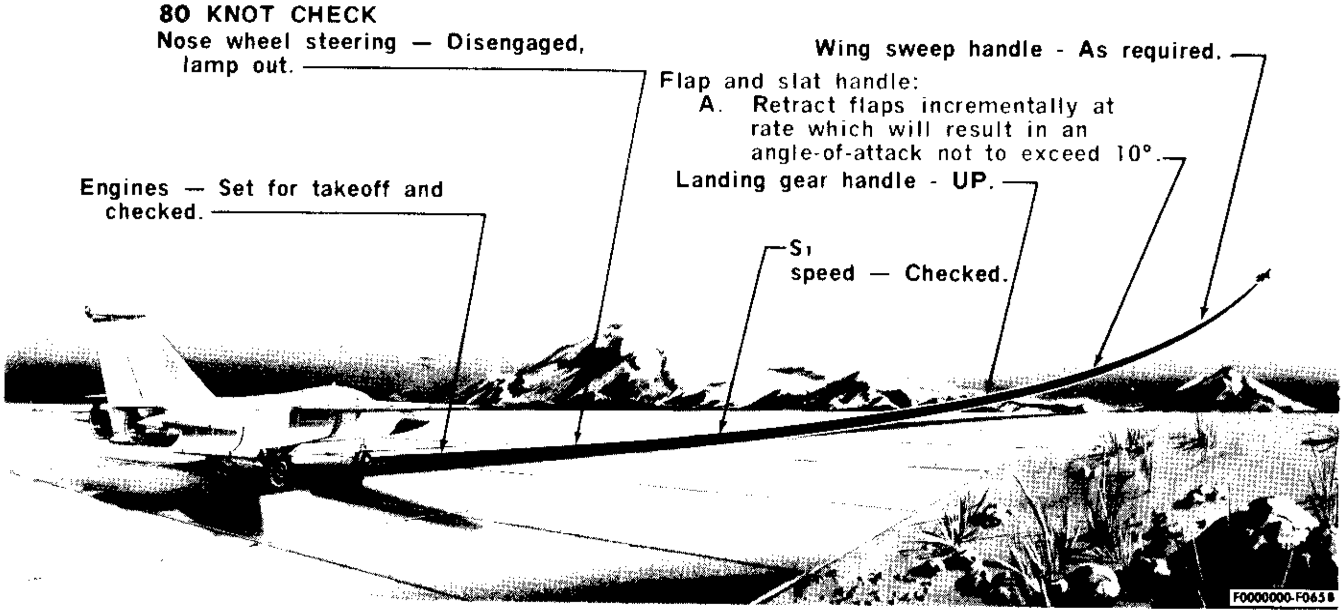
Immediately after nose wheel lift off, a forward stick motion may be required to arrest the rotation of the aircraft, and the stick should be adjusted to maintain 10 degrees of pitch attitude for aircraft lift off. Landing gear retraction should be initiated when safely airborne. After lift off, maintain this attitude constant and as the aircraft accelerates retract the flaps/slats incrementally at a rate which will result in an angle-of-attack not to exceed 10 degrees. During heavy gross weight takeoff conditions (above 90,000 pounds) it will be necessary to maintain angle-of-attack between 8 and 10 degrees to avoid exceeding the flap limit speed.

WARNING

- Excessive angle-of-attack may result from retracting flaps too rapidly.
- Maneuvering flight at angles-of-attack greater than 10 degrees should be avoided.

For typical takeoff, see figure 2-4. Refer to the Performance Appendix for takeoff data.

Takeoff (Typical)



F0000000-F065B

Figure 2-4.

CAUTION

Failure to arrest rapid rotation rates generated at nose wheel lift off can result in aircraft tail bumper and/or engine tail feathers contacting the runway.

CROSSWIND TAKEOFF.

Under crosswind conditions, the aircraft tends to weather-vane into the wind. The weather-vaning tendency can be easily controlled with nose wheel steering until the rudder becomes effective. As forward speed increases, the weather-vaning tendency decreases. At speeds above approximately 50 knots rudder effectiveness will normally be sufficient to maintain directional control. Use of roll control will aid directional control and keep the wings level. Care should be exercised, however, to prevent inducing an excessive wing-low attitude at lift-off.

Note

Application of roll control may delay rotation due to a slight reduction in available pitch control.

After the aircraft leaves the ground, it should be crabbed into the wind, wings level, to maintain runway alignment. Refer to "Crosswind Takeoff and Landing Limits," Section V.

AFTER TAKEOFF/CLIMB. (NAV READS)

The ➧ items will be accomplished when climbing out of low level routes.

1. Landing gear handle—UP.
   When the aircraft is definitely airborne, retract the landing gear. Check that the landing gear position indicator lamps and the warning lamp in the landing gear handle go out. The landing gear and landing gear doors should be up and locked before reaching 295 KIAS.

WARNING

If it is necessary to depress the landing gear handle lock release button to move the handle to the UP position, the crew member should suspect a malfunction of the landing gear ground safety switch. In this event the spoilers will remain armed even with the landing gear retracted and the ground roll spoiler switch should be placed to OFF

Note

The fuel tank pressurization caution lamp may light when the landing gear handle is moved to the UP position and remain lighted until the tanks are pressurized.

2. Flap/slat handle:
   a. Flaps—Retract flaps incrementally at a rate which will result in an angle-of-attack not to exceed 10 degrees.

WARNING

- Excessive angle-of-attack may result from retracting flaps too rapidly.
- If aircraft starts to roll off while retracting the flaps immediately return the flap/slat handle to original position and make no further attempts to operate the flaps. Sufficient lateral control may not be available to counter an asymmetrical flight condition. Refer to the appropriate procedure under "Landing With Flap And Slat Malfunctions," Section III.

   b. Slats—UP, and verified.
      Retract slats after verifying flaps are full up. Check that slat/aux flap indicator displays UP.

Note

- The rudder authority caution lamp will light momentarily while slats are in transit.
- Maintain 1 "g" until slats/flaps are fully retracted.

♦ 3. Wing sweep handle—As required.

CAUTION

If the slat/aux flap indicator displays crosshatch, do not sweep the wings without other verification that the flaps are up.

♦B 4. Thermal curtains—Closed. (EWO only)

WARNING

Failure to close thermal curtains as soon as possible after takeoff may result in flash blindness from nuclear detonations.

♦ 5. Auto TF switch—OFF.

♦ 6. Throttles—As required.
   For military power climb reduce throttles to MIL when climb speed is attained.

7. Ground jettison switch—OFF, guard down.

8. Release enable switch—INHIBIT.

9. Nuclear consent switch—OFF.

N 10. Station select switches (all external bombs/missiles)—Deselected.

♦B 11. Engine instruments—Checked.

♦B 12. Fuel quantity indicators—Checked.
   Check the fuel quantity indicators for normal fuel usage.

♦N 13. TFR mode selector knobs (2)—STBY.

N 14. Nav modes—Selected.

N 15. SRAM cooling switch—As required.
   If missile system is to be energized during the mission, apply SRAM cooling to missiles during climb at approximately 5000 feet altitude.

CAUTION

To prevent unnecessary condensation within missile IMU or ingestion of sand and dust during low level operations, operate the SRAM cooling switch throughout the flight in accordance with the limitations established in T.O. 1F-111(B)A-30-1.

♦B 16. Oxygen and cabin altitude—Checked.

N 17. Photo mode selector switch—AUTO.

♦B 18. Altimeters—Reset.

CLIMB.

The recommended climb speed, as shown in Appendix I, should be followed.

LEVEL OFF.

B 1. Station check—Completed.
2. ISC—As desired.
N 3. HF radio—SSB.
N 4. IRRS function selector—As desired.
N 5. ECM mode selectors (3)—REC. (If installed)
N 6. RHAW power/audio control knob—As desired.
7. Radar altimeter—Set to 5000 feet.
N 8. System power(CAE)—As required.

CAUTION

Do not open the weapon bay doors inflight if a flight data recorder is installed (as indicated in the Form 781).

Note

Refer to crew duties, Section IV for inflight procedures.

CODED SWITCH SET CONTROLLER (CSSC) ENABLING. (BOTH)

CSSC enabling will be accomplished as soon as possible after receipt of a valid "go-code."

Note

For any abnormal indications, refer to "Coded Switch Set Malfunction Analysis," Section III.

1. Coded switch set controller (CSSC):
   a. Lamp test button—Depressed.
   b. Enable code —Set.
   c. Operate/monitor switch—OPER.
   d. CODE and ENABLE lamps—Lighted.
   e. Operate/monitor switch—MON. (Momentarily)

Note

System status (enable/disenable) may be verified at any time by holding the operate/monitor switch in MON and observing DISEN and ENABLE lamp indication.

CRUISE.

After transfer of all external, weapon bay, and wing tank fuel, check fuselage fuel quantity indicators for normal distribution and usage. Forward and aft together should equal totalizer, (±1000) pounds.

WARNING

Failure of either forward or aft indicator pointers will cause improper forward and aft tank fuel distribution if engine feed is in AUTO. Do not remain in AUTO. Fuel distribution must be controlled manually to maintain cg within safe limits. A redundant fuel distribution monitoring system is included to provide aft center-of-gravity monitoring in any mode of engine feed. Refer to "Abnormal Fuel Distribution/Indication," Section III.

Refer to Appendix I for cruise operating data. Refer to Section I for fuel system operation.

AIR REFUELING.

Refer to T.O. 1-1C-1 for general air refueling procedures and to T.O. 1-1C-1-21 for specific air refueling procedures for this aircraft.

BEFORE DESCENT. (NAV READS)

Note

The navigator will monitor aircraft altitude, airspeed, angle-of-attack, configuration, and position during penetration, approach, and missed approach. Reference will be made to the applicable FLIP chart to ascertain that the aircraft is following the established pattern. The pilot will be notified of any significant deviation from the desired parameters, penetration, approach or missed approach pattern.

B 1. Penetration and approach procedures—Checked.
   a. Letdown plate—Reviewed
   b. Altitude calls—Reviewed
   The navigator will announce the altitude when passing 15,000, 10,000, and 5,000 feet MSL. He will also notify the pilot 1,000 feet above initial level off and when approaching the DH/MDA. Both crew members will cross-check altimeters during descent.
2. Radar altimeter—Set.
   Set the radar altimeter to the absolute altitude that corresponds to the DH/MDA.
B 3. Fuel panel and quantity—Checked.
   Check fuselage fuel indicator totals against totalizer reading (±1000) pounds. If engine feed is in AUTO, verify normal distribution. If aft tank is empty (pump lamps lighted) switch to FWD.

N 4. Landing data—Checked.
Compute approach speed and stopping distance for initial landing/approach weight and configuration. If runway conditions remain the same, only approach speed need be computed for subsequent approaches and landing. If desired, compute wing sweep for landing from "Wing Sweep For Landing" chart.

5. Wing sweep handle and lockout controls—Set 26 degrees, ON.
Check wing position indicator to assure wings moved to position selected.

6. *Cabin air distribution control* lever—As required.

7. Anti-skid switch—ON, caution lamp out.

B 8. Oxygen—As required.

9. ISC/HSI course set knob—As required.

10. Ground roll spoiler switch—As required.

B 11. Altimeters—Set.

12. Damper Switches (3)—DAMPER.

N 13. TFR mode selector knobs—STBY.

N 14. RHAW system power/audio knob—OFF.

N 15. CMDS—Checked, SAFE and OFF.

N 16. ECM control knobs (3)—OFF.

N 17. IRRS function selector knob—OFF.

Note

Accomplish items 18 thru 26 if bombs/missiles are aboard the aircraft.

N 18. Option select switch—MON.

N 19. Nuclear caution lamp—Out.

N 20. Option select switch—OFF.

Note

Accomplish step 21 if electrical power is still applied to missiles or SRAM CAE.

N 21. AGM-69A control and display panel:
a. Select and monitor knob—ALL.
b. Power switch—OFF. (Momentarily)
Check SRAM PWR lamp out.
c. Select and monitor knob—CAE.
SRAM PWR lamp will be lighted in the CAE position.
d. Power switch—OFF. (Momentarily)
Check malfunction and status indicator lamps out.

N 22. Nuclear unlock circuit breaker—Out.

N 23. Stores control panel:
a. Release enable switch—INHIBIT.
b. Master switch—OFF.
c. Delivery mode knob—OFF.
d. *Selector mode* knob—OFF.

24. Nuclear consent switch—OFF, guard down.

25. Dangerous cargo radio call—Accomplished.

N 26. SRAM cooling switch—OFF.
Shut down SRAM cooling to missiles when *descending through approximately* 5000 feet altitude.

CAUTION

If missiles electronic power could not be removed, do not remove SRAM cooling. Positioning the SRAM cooling switch to OFF with missile electronic power applied can result in missile overheat damage.

Note

Accomplish items **N**27 through **N**35 for all AILA/Monitored Approaches.

N 27. Function Select Knob—NAV.

N 28. Selected sequence point pushbutton—DEST.

N 29. Fix mode selector knob—DEST.

N 30. *Present position correction switch*—IN.

N 31. Glide angle—Set to nearest 0.1 degree.

N 32. ODS mode selector knob—CMD. (If required)

N 33. Aiming reticle cage lever—Uncage. (If required)

N 34. Altitude calibration—Completed.
Perform a low altitude calibration over the runway of intended landing if possible. If the cursors were repositioned to the end of the runway/offset and present position was not updated, when exiting the altitude calibration mode the cursors will jump the amount of present position error, and must be repositioned to the runway/offset.

N 35. Attack radar cursors—Positioned.
Place the cursors as precisely as possible on the desired touchdown point or OAP. Prior to selecting AILA on the ISC, if the cursors are repositioned to the end of the runway/offset and present position is not updated, the cursors will jump the amount of present position error when AILA is selected on the ISC, and must be repositioned to the runway/offset.

BEFORE LANDING. (NAV READS)

Note

See figure 2-5 for "Final Approach Airspeeds."

Final Approach Airspeeds

DATA BASIS: ESTIMATED
DATE: 3 FEBRUARY 1970

CONFIGURATION:
- CLEAN AIRCRAFT
- FULL FLAPS/SLATS

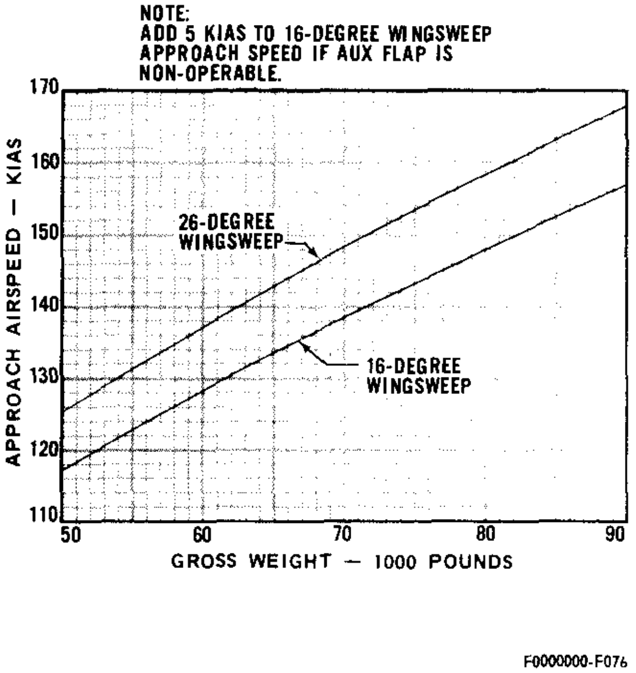


Figure 2-5.

1. Speed brake switch—IN.
2. Wing Sweep—Set for landing and checked.
   Use one of the following procedures to determine wing sweep for landing.
   a. Elevator check—Complete.
      The elevator check may be performed at mach 0.70 or below and below 20,000 feet MSL in level flight with 26 degrees wing sweep and speed brake retracted. If the elevator trailing edge deflection is between 2 degrees trailing edge up and 1 degree trailing edge down, 26 degrees sweep should be used for landing. If the elevator trailing edge deflection is greater than 2 degrees trailing edge up, the wing should be swept forward until an elevator position of 0 degrees or 16 degrees wing sweep is reached. This wing sweep should be used for landing. For trailing edge deflections greater than 1 degree trailing edge down, refer to "Landing With Abnormal Fuel Distribution," Section III.
   b. Wing sweep from chart—Determined.
      Determine wing sweep for landing by referring to the "Wing Sweep for Landing" chart (if not previously determined).

Note

- The wings must be at 26 degrees or less to allow flap/slat extension.
- Prior to slat/flap extension, maintain an airspeed (250-300 KIAS) compatible with aircraft configuration and gross weight to insure that 10 degrees angle-of-attack is not exceeded during maneuvering flight conditions or during aircraft configuration changes.

3. Landing gear handle—DN.
   Extend the landing gear after airspeed is below 295 KIAS. Check that warning light in landing gear handle is out and landing gear position indicator lights are lighted.

WARNING

- After landing gear extension, selection of slats/flaps during decelerating flight should not be delayed, and extension of slats should be accomplished while gear is in the extend cycle. The command augmentation feature masks stall warning characteristics and rapid drag rise as airspeed decreases without slats and flaps extended. This may result in a rapid increase in angle-of-attack which the pilot may not be able to arrest before critical angle-of-attack limits are exceeded.
- Under landing conditions wherein airspeed may be above the gear warning horn setting, 160 (±12) KIAS, exercise caution to insure the landing gear is down and locked.

Note

The pitch and roll gain changer caution lamps will light when the gear is extended and will remain lighted until the slats are extended to approximately 70 percent.

4. Slats—Extend. (240 KIAS minimum.)
   Extend the slats while the gear is in the extend cycle by positioning the flap/slat handle to the slat gate and make positive verification of slat position using the wing sweep flap/slat position indicator, visual check of slats and/or observation of the gain changer caution lamps. Since the gain changer caution lamps will remain lighted until the slats have extended to approximately 70 percent, this will provide an indication of slat position. When the gain changer caution lamps go out, extend the flaps. If the gain changer lamps remain lighted, and 70 percent slat extension cannot be verified by other means, do not extend flaps; refer to Section III.

WARNING

- For normal operation, slats should be extended by a minimum airspeed of 240 KIAS. Do not roll or execute abrupt maneuvers with slats only extended.
- Do not extend flaps by normal or emergency method until approximately 70 percent slat extension has been verified. To do so could result in the flaps being locked at approximately 15 degrees with zero (or partial) slat extension. Flight in this configuration could result in stall or uncontrolled roll off. If the system locks, refer to "No (Or Partial) Slats And Partial Flaps Landing", Section III.

Note

- In the event flaps/slats do not extend with the wing sweep handle at the 26 degree detent, move the handle slightly forward of 26 degrees and reattempt extension.
- Airloads may prevent full slat extension at airspeeds approaching the slat limit speed; however, as airspeed is reduced resultant lowering of airloads will allow full slat extension.
- Maintain 1 "g" wings level until slats/flaps are extended to the desired position.

5. Flaps—Down and verified:
   a. Flaps—Down to 15 degrees.

WARNING

If aircraft starts to roll off after the slat/flap handle is placed to the 15 degree position, sufficient lateral control is available to counter an asymmetrical flight condition. Refer to "Asymmetric Flap," Section III.

   b. Flaps—Full down.
6. ISC/HSI course set knobs—As required.
7. Landing light—On.
8. Elevator position indicator (EPI)—Check. At 10 degrees angle-of-attack, check elevator position. If the elevator position is between 12 degrees trailing edge up (forward limit) and 4 degrees trailing edge up (aft limit) at 26 degrees wing sweep, or between 15 degrees trailing edge up and 6 degrees trailing edge up (12 and 4 respectively with auxiliary flaps) at 16 degrees wing sweep, the aircraft is within the center-of-gravity limits. For wing sweeps between 26 and 16 degrees, linearly interpolate using the elevator position values for no auxiliary flaps at 16 degrees wing sweep and values of 12 degrees (forward limit) to 4 degrees (aft limit) trailing edge up for 26 degrees wing sweep. If the elevator position is not in the above envelope, sweep the wing until it is. As the wing is swept forward from 26 degrees, the elevator required to trim will move in the down direction.

Note

The above elevator position range will provide safe operation for all landing wing sweeps and store loadings. For the aft limit for landing with a specific configuration, refer to Section V.

LANDING.

Note

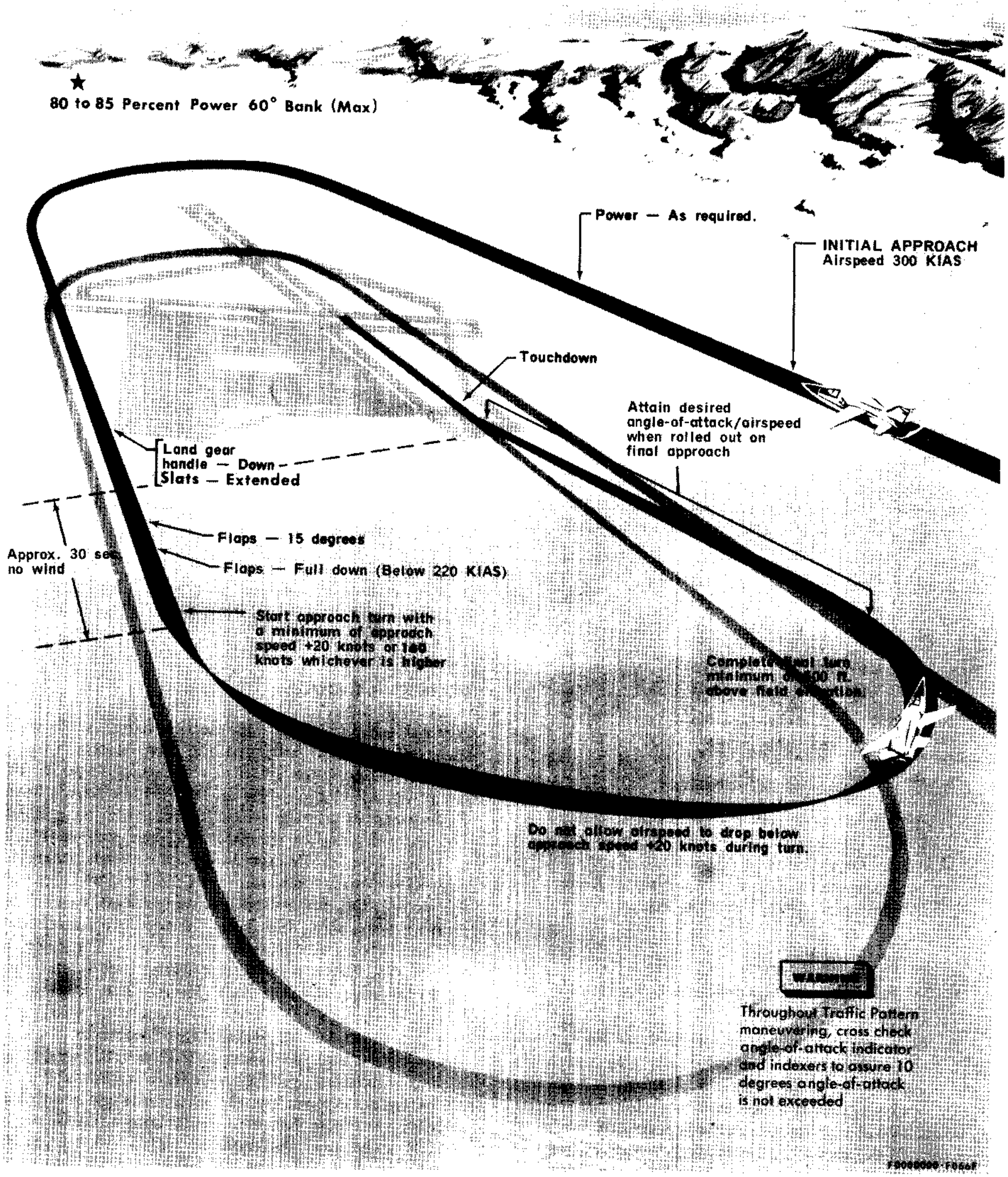
See figure 2-6 for typical "Landing Pattern" and airspeeds.

Brakes should be used as required compatible with runway available. For Landing Data, refer to the Performance Appendix.

NORMAL LANDING.

Normal landings should be accomplished with wing sweep as required, full flaps and the pattern flown as illustrated on figure 2-6. For clean configuration, the initial approach should be entered at 300 KIAS. Enter the pattern as local policies dictate, using the throttles as necessary to maintain pattern airspeeds and altitudes. During the crosswind turn, do not exceed 60 degrees of bank maximum and adjust power to 80-85 percent. On downwind leg, wings level, extend the landing gear, slats, and flaps. Do not decelerate below 240 KIAS prior to full extension of slats. Flaps should be extended by a two-step procedure; first, extend flaps to 15 degrees, then to full down when below 220 KIAS. Although trim changes associated with gear and flap extensions are small, a noticeable decrease in angle-of-attack (approximately 0.25 degree per degree of flap extension) will be evidenced as slats and flaps are extended. Approximately 30 seconds (no wind condition), start base leg turn, with computed final approach speed plus 20 knots or 160 KIAS minimum, whichever is higher. Do not allow airspeed to drop below final approach speed plus 20 knots until rolled out on final approach.

Landing Pattern (Typical)



Fig

WARNING

Throughout traffic pattern maneuvering, cross check the angle-of-attack indicator and indexers to assure 10 degrees angle-of-attack is not exceeded.

Complete the final turn with minimum clearance of 500 feet above field elevation. After rolling out on final approach and establishing the desired glide angle, adjust power as necessary to attain approach angle-of-attack indexer "on-speed" indication.

Note

Verify "on-speed" indexer operation by cross checking against angle-of-attack indicator and indicated airspeed.

Flying a 3.0 degree glide slope will produce a rate of descent of approximately 700 feet per minute. Use the angle-of-attack indexer to maintain an "on-speed" indication during final approach since this represents optimum approach angle-of-attack and airspeed and will automatically adjust airspeed for the gross weight of the aircraft.

Note

Turbulence, gusty winds, or other conditions may exist which may induce variations in angle-of-attack or airspeed or cause excessive sink rates to develop on final approach. The pilot may decrease angle-of-attack to eight degrees or increase final approach speed 10 knots in such cases to improve aircraft handling characteristics. To avoid undesirable touchdown characteristics, this additional airspeed should be dissipated so that an "on-speed" indication exists prior to initiation of flare.

After the aircraft enters ground effect (approximately 30 to 50 feet above the ground), the aircraft will tend to rotate in the nose-down direction. At this point, the pitch attitude should be increased slightly (3-4 degrees) to reduce the descent rate to approximately one-half that used on final approach. Allow the aircraft to touch down in this attitude. This results in a "slow" indication at touchdown. After establishing touchdown attitude, reduce power slightly to lower aircraft to runway. Upon touchdown, smoothly retard throttles to IDLE, then lower nose wheel to runway. No attempt should be made to "grease" the aircraft on, as this delays compression of the struts and subsequent spoiler extension. A firm touchdown will allow spoiler extension when throttles are retarded to IDLE and result in a more comfortable and safer landing. When the spoilers extend, the aircraft will tend to fall through due to the center of rotation being shifted from the aircraft center of gravity to the main gear. Maintain directional control with rudder and differential braking until ready to turn off the runway or turn around on the runway. Normally nose wheel steering should not be engaged until speed has decreased to normal taxi speed. Normal ground roll distance is computed with brakes applied at 80 knots; however, brakes can be used throughout the landing roll. Refer to Appendix I for landing data.

WARNING

- Under no circumstances, during the landing phase, should the 14 degree angle-of-attack or stall warning activation limit be exceeded. Possible inadvertent stall and post-stall gyrations can result from exceeding this limit.
- Flying a steeper than normal final approach and/or not maintaining sufficient power through the flare for landing, may cause sink rates to exceed aircraft and landing gear design limits and increase the possibility of landing short of the runway.

CAUTION

Rapid or abrupt lateral or longitudinal stick motions can cause momentary increases in rate of sink and therefore should be avoided.

SHORT FIELD LANDING.

A short field landing is accomplished in the same manner as a normal landing except that particular attention must be given to precise airspeed, angle-of-attack, and glide slope control. Touchdown should be as close to the end of the runway as possible, with no landing flare. Observe sink rate limits. Refer to Section V. Reduce the power to IDLE at touchdown if this has not previously been done. Allow the aircraft to settle on the main landing gear and the ground roll spoilers to extend. After the spoilers have extended and the nose wheel is firmly on the runway, apply maximum anti-skid braking. Maximum braking performance is obtained in three-point attitude with maximum weight on the main landing gear. Because of this, the stick should be eased aft when the brakes are applied, but caution should be exercised to insure that the nose

wheel does not rise from the runway. The stick can be brought to the full aft position without unsticking the nose wheel at speeds below approximately 90 KIAS. Be prepared to lower the arresting hook and engage the runway barrier if the aircraft cannot be stopped prior to reaching the end of the runway. Maximum braking should be released, if practical, at approximately 25 knots to prevent the brakes from fusing and immobilizing the aircraft on the runway. At light gross weights, the anti-skid system cycling will be quite extreme and will continue throughout the ground roll until just before the aircraft is stopped. At heavier gross weights, little anti-skid cycling will be noted. If safety or operational considerations dictate that the ground roll must be the absolute minimum possible, touchdown can be made with full anti-skid braking applied.

HEAVY GROSS WEIGHT LANDING.

A heavy gross weight landing will be accomplished with a 16 degree wing sweep (if cg permits) in the same manner as a normal landing except that, maintaining an on-speed indication will result in higher approach and touchdown speeds. These higher speeds, due to heavier weights, result in increased braking requirements and stopping distances. Refer to Appendix I for landing data.

HYDROPLANING.

WARNING

> If hydroplaning conditions exist, the landing roll will be increased by an indeterminate amount; therefore, be prepared for a departure end barrier engagement.

Dynamic hydroplaning is a condition where the tires of the airplane are separated from the runway surface by a fluid. Under conditions of total dynamic hydroplaning, the hydrodynamic pressures between the tires and runway lift the tires off the runway to the extent that wheel rotation slows or actually stops. The major factors in determining when an airplane will hydroplane are groundspeed, tire pressure, and depth of water on the surface. To a lesser degree, the surface texture, type of tire, and tire tread depth influence the total hydroplaning speed. Total dynamic hydroplaning in this airplane with recommended tire pressure and .1 inch or more of water or slush on the runway can be expected at approximately 115 knots groundspeed (main landing gear) and 150 knots groundspeed (nose wheel) considering a takeoff gross weight of 86,000 to 90,000 pounds. These speeds will change as tire pressure is varied for takeoff gross weight. Partial dynamic hydroplaning occurs to varying degrees below these speeds. When an airplane is subjected to hydroplaning to any degree, directional control becomes difficult. Under total dynamic hydroplaning conditions, nose wheel steering is ineffective and wheel braking is nonexistent. In addition to dynamic, two other types of hydroplaning can occur. Viscous hydroplaning can occur on a damp runway and at speeds less than those associated with dynamic hydroplaning, and is caused by a thin film of water mixed with rubber deposits and/or dust. Reverted rubber hydroplaning is caused by skid which boils the water on the runway, causing the rubber to revert to its natural latex state and seals the tire grooves, delaying water dispersal. Reverted rubber hydroplaning can occur at very low airspeeds. When possible hydroplaning conditions exist, pilots should be aware of the following:

1. Smooth tires tend to hydroplane with as little as .08 inch of water. New tires tend to release hydrodynamic pressures and will require in excess of .2 inches of water depth to hydroplane.
2. Takeoffs with crosswinds on water covered runways should be made with caution. An aborted takeoff on a wet runway initiated at or near hydroplaning speed will require considerably more runway than a dry runway abort and directional control of the airplane will be critical until the speed has decreased below hydroplaning velocity.
3. In the absence of accurately measured runway water depths, pilots may use the following information to determine the possibility of hydroplaning when landing must be accomplished on a wet runway that does not have a porous surface or is not grooved:
    a. Rain reported as LIGHT—Dynamic hydroplaning unlikely, viscous and reverted rubber hydroplaning are possible.
    b. Rain reported as MODERATE—All types of hydroplaning are possible. Smooth tires will likely hydroplane; however, new tires are less likely to hydroplane.
    c. Rain reported as HEAVY—Hydroplaning will occur.

LANDING ON SLIPPERY RUNWAYS.

72-2

The technique for a slippery runway landing is essentially the same as that for a short field landing. During the high speed portion of the landing roll, particularly under wet or icy conditions, little braking capability will be available. This is because of the low coefficient of friction available due to hydroplaning or a very low RCR. Maximum aerodynamic braking should be used throughout the landing roll to aid in decelerating the airplane. To avoid inhibiting wheel spin-up, and to

improve wet runway wheel cornering capability, insure that the aircraft is firmly on the runway and positively under control prior to applying brakes. On wet runways during the high speed portion of the roll, little deceleration will be felt due to rapid anti-skid cycling. As speed decreases, braking potential on a wet runway will increase and brakes should be applied as required to stop the airplane. On an icy runway, the coefficient of friction will remain fairly constant throughout the landing roll and brakes should be applied as required. Aerodynamic control, differential braking and nose wheel steering may be used to maintain directional control. Nose wheel steering should not be required until areodynamic control becomes ineffective. If planned stopping distance indicates that a stop on the runway is doubtful, divert or make either an approach end or departure end barrier engagement, depending on the severity of the situation. Refer to Appendix I for ground roll distance for various runway conditions.

CROSSWIND LANDING (DRY RUNWAY).

72-2

When crosswind conditions are encountered, a crab technique on final approach should be used to compensate for drift. Under visual conditions a wing-low drift correction technique may be used, however, airspeed and glidepath control becomes more difficult. Additionally, when the airscraft sideslips to the right, airflow to the angle of attack sensor begins to be blanked by the aircraft nose at a sideslip angle of approximately 10 degrees. As the sideslip angle is increased beyond this point, the angle of attack sensor indicates increasingly lower values of angle of attack. Therefore, it is recommended that steady-state rudder inputs be kept below seven degrees as inputs of a larger magnitude may result in erroneous angle of attack indications. Sideslip to the left will not affect the angle of attack sensor; therefore, the aircraft may sideslip to the left to the limits presented in the flight manual. During the transition to touchdown (approximately 75 feet above the ground), the drift correction technique should shift gradually from a crab to a wing low crabbed correction at touchdown. The pilot should attempt to touch down with no drift and the longitudinal axis of the aircraft aligned with the runway, which will minimize sideloads on the landing gear. However, if the crosswind component is excessive, it will be necessary to land in a combination wing-low crabbed attitude, not to exceed 10 degrees yaw or crab angle at touchdown.

CAUTION

External tanks at stations 2 or 7 will contact the ground at a bank angle of 15 degrees.

During touchdown from a wing-low crabbed approach, the pilot may experience the sensation of bouncing from gear to gear which may be aggravated by use of roll control in attempting to keep the wings level. The probability of this occurring will be reduced if a firm touchdown at the recommended angle of attack is accomplished. If this condition is encountered, minimize use of roll control until the aircraft has settled through the struts and is firmly on the ground. After touchdown, the pilot should use rudder, roll control and differential braking as required to maintain directional control. Roll control effectiveness may be increased significantly by "cracking" a throttle, thereby retracting the spoiler brakes and allowing the spoilers to function as an aid to roll control. When the desired directional control change is achieved, return the throttle to idle to extend the spoiler brakes. If nosewheel steering is required, it should be initiated with the rudder pedals at or near neutral, since the nosewheel will rapidly assume a position relative to the rudder pedal position at engagement. Unless required for directional control, nosewheel steering should not be engaged until the aircraft has slowed to taxi speed and just prior to turning off the runway. When landing with slats/flaps up, refer to "Crosswind Takeoff And Landing Limits," Section V, for recommended touchdown technique and limits. When landing with augmentation off, refer to "Dampers Off Landing", Section III.

CROSSWIND LANDING (SLIPPERY RUNWAY).

72-2

The problem of maintaining directional control on a slippery runway becomes more difficult as the effective crosswind is increased. Consequently, aircraft flight path alignment with the runway must be established during the approach to prevent drift at touchdown. Restricted visibility, poor ground references, and crab angle will further complicate the task of establishing alignment during the approach. Pilots should be aware that excessive maneuvering during the final phase of the approach may induce misalignment and/or drift and may make it impossible for the pilot to determine actual aircraft track.

WARNING

Proper runway alignment for approaches and landings under low RCR conditions is extremely critical. Avoid excessive maneuvering on final approach under these conditions. Aircraft drift or flight path misalignment at touchdown increases susceptibility to skidding or hydroplaning, which may cause loss of directional control during landing roll. If aircraft drift is not corrected prior to touchdown, execute a missed approach.

Plan the landing pattern to be established on final approach using a crab technique to correct for drift. This will insure that the aircraft is tracking straight down the center line of the runway. Establish a normal rate of descent and plan to touch-down approximately 500 feet down the runway or at the glide slope/runway interception point (if applicable). Make a firm touch-down with no flare (observe sink rate limitations, Section V) while maintaining the drift correction. Touching down in a crab will help insure that the runway center line track is maintained. Due to visibility restrictions that may occur with a crabbed approach, a combination crabbed/wing-low technique may be necessary during the transition to touchdown. Immediately after touchdown, retard throttles to idle and lower the nose to the runway. Aerodynamic (rudder and roll) control, differential braking, and nose-wheel steering may be used to maintain directional control; however, nose-wheel steering should not be required until aerodynamic control becomes ineffective. Roll control effectiveness will be increased significantly by "cracking" a throttle, thereby retracting the spoiler brakes and allowing the spoilers to function as an aid to roll control. When the desired directional control change is achieved, return the throttle to idle to extend the spoiler brakes. If nose-wheel steering is engaged, inputs should be kept small as steering effectiveness diminishes rapidly with nose-wheel deflections of more than 10°.

Note

- If directional control cannot be established or maintained, immediately advance power as required to accomplish a go-around.
- After directional control is well established, use the technique described under landing on Slippery Runways, this section, to stop the aircraft.

LANDING WITH PARTIAL FLAPS.

A partial flap landing is accomplished in the same manner as a normal landing except that, maintaining an "on-speed" indication will result in higher approach and touchdown speeds (approximately 1.7 knots increase in airspeed for each degree of flap less than full flaps with 16 to 26 degree wing sweep). Due to the higher approach and touchdown speeds, braking requirements as well as stopping distances will be increased.

LANDING WITH SLATS EXTENDED AND FLAPS RETRACTED OR WITH SLATS AND FLAPS RETRACTED.

Approaches with wings and flaps in other than normal landing configuration will necessitate a long shallow, straight-in approach. If it is necessary to land the aircraft in this configuration, refer to "No Flap Landing," Section III.

TOUCH AND GO LANDINGS.

Touch and go landings should be accomplished using the same technique as presented in the "Normal Landing" and "Normal Takeoff" procedures this section. After touchdown power should be reduced to IDLE to allow the aircraft to decelerate and the nose wheel lowered to the runway. Directional control should be maintained with the rudder pedals. After the nose wheel has been lowered to the runway, smoothly advance the throttles to MIL or AB power as required. Check engine instruments for normal indications and caution lamps for malfunction warning. Lift nose wheel off runway 10 knots below previous approach speed. Accomplish "Transition Checklist" prior to each "Touch and Go Landing." If the aircraft reenters normal visual traffic, retract flaps/slats and accelerate to 300 KIAS (250-300 KIAS for rectangular traffic pattern). For subsequent radar patterns, traffic density will dictate airspeed and flap/slat position.

TRANSITION CHECKLIST.

When making a series of approaches and/or landings, this checklist will be used in lieu of "Before Landing" checklist provided the "Before Landing" checklist was accomplished prior to the initial approach and/or landing.

On the Go:

1. Speed brake switch—IN.
2. Power—Advanced.
B 3. Engine instruments—Checked.
4. Landing gear handle—UP.
5. Flap/slat handle:
   a. Flaps—Retract flaps incrementally at a rate which will result in an angle-of-attack not to exceed 10 degrees.

WARNING

- Excessive angle-of-attack may result from retracting flaps too rapidly.
- If aircraft starts to roll off while retracting the flaps immediately return the flap/slat handle to original position and make no further attempts to operate the flaps. Sufficient lateral control may not be available to counter an asymmetrical flight condition. Refer to the appropriate procedure under "Landing With Flap and Slat Malfunctions," Section III.

- If any malfunction is indicated or suspected during flap retraction it is recommended, flight conditions permitting, that the flaps not be further actuated until over an approved drop or unpopulated area. A landing utilizing normal landing procedures can be accomplished if the slats/flaps return to original position. If they do not, refer to the appropriate procedure under "Landing With Flap and Slat Malfunctions," Section III.

b. Slats—UP, and verified.
Retract slats after verifying flaps are full up. Check that slat/aux flap indicator displays UP.

Note

- The rudder authority caution lamp will light momentarily while slats are in transit.
- Maintain 1 "g" wings level until slats/flaps are fully retracted.

On Downwind (Nav Reads):

6. Wing sweep handle—Set for landing.
7. Hydraulic pressure—Checked.
Check for 2950 to 3250 psi indication.

B 8. Fuel quantity and feed—Checked.

N 9. Landing data—Checked.

10. Landing gear handle—DN.
Extend the landing gear after airspeed is below 295 KIAS. Check that warning light in landing gear handle is out and landing gear position indicator lights are lighted.

WARNING

- After landing gear extension, selection of slats/flaps during decelerating flight should not be delayed, and extension of slats should be accomplished while gear is in the extend cycle. The command augmentation feature masks stall warning characteristics and rapid drag rise as airspeed decreases without slats and flaps extended. This may result in a rapid increase in angle-of-attack which the pilot may not be able to arrest before critical angle-of-attack limits are exceeded.
- Under landing conditions wherein airspeed may be above the gear warning horn setting, 160 (±12) KIAS, exercise caution to insure the landing gear is down and locked.

Note

The pitch and roll gain changer caution lamps will light when the gear is extended and will remain lighted until the slats are extended to approximately 70 percent.

11. Slats—Extend. (240 KIAS minimum)
Extend the slats while the gear is in the extend cycle by positioning the flap/slat handle to the slat gate and make positive verification of slat position indicator, visual check of slats and/or observation of the gain changer caution lamps. Since the gain changer caution lamps will remain lighted until the slats have extended to approximately 70 percent, this will provide an indication of slat position. When the gain changer caution lamps go out, extend the flaps. If the gain changer lamps remain lighted, return the flap/slat handle to up and make a "No Flap Landing," refer to Section III.

WARNING

- For normal operation slats should be extended by a minimum airspeed of 240 KIAS. Do not roll or execute abrupt maneuvers with slats only extended.
- Do not extend flaps by normal or emergency method until approximately 70 percent slat extension has been verified. To do so could result in the flaps being locked at approximately 15 degrees with zero (or partial) slat extension. Flight in this configuration could result in stall or uncontrolled roll off. If the system locks, refer to "No (Or Partial) Slats And Partial Flaps Landing," Section III.

Note

- In the event slats/flaps do not extend with the wing sweep handle at the 26 degree detent, move the handle slightly forward of 26 degrees and reattempt extension.
- Airloads may prevent full slat extension at airspeeds approaching the slat limit speed; however, as airspeed is reduced resultant lowering of airloads will allow full slat extension.
- Maintain 1 "g" wings level until slats/flaps are extended to the desired position.

12. Flaps—Down and verified.
a. Flaps—Down to 15 degrees.

WARNING

If aircraft starts to roll off after the slat/flap handle is placed to the 15 degree position, sufficient lateral control is available to counter an asymmetrical flight condition. Refer to "Asymmetric Flap," Section III.

b. Flaps—Full down.

13. ISC/HSI course set knob—As required.
14. Landing lights—On.
15. Elevator position indicator (EPI)—Check. At 10 degrees angle-of-attack, check elevator position. If the elevator position is between 12 degrees trailing edge up (forward limit) and 4 degrees trailing edge up (aft limit) at 26 degrees wing sweep, or between 15 degrees trailing edge up and 6 degrees trailing edge up (12 and 4 respectively with auxiliary flaps) at 16 degrees wing sweep, the aircraft is within the center-of-gravity limits. For wing sweeps between 26 and 16 degrees, linearly interpolate using the elevator position values for no auxiliary flaps at 16 degrees wing sweep and values of 12 degrees (forward limit) to 4 degrees (aft limit) trailing edge up for 26 degrees wing sweep. If the elevator position is not in the above envelope, sweep the wing until it is. As the wing is swept forward from 26 degrees, the elevator required to trim will move in the down direction.

Note

The above elevator position range will provide safe operation for all landing wing sweeps and store loadings. For the aft limit for landing with a specific configuration, refer to Section V.

SIMULATED SINGLE ENGINE LANDING.

Simulated single engine landing should be flown with one engine at idle rpm, following the "Single Engine Go-Around," procedure, Section III.

GO-AROUND.

The decision to go around should be made as early as possible. When the decision to go around is made, smoothly advance the throttles and continue the approach because a touchdown may be necessary. As the aircraft accelerates, rotate the nose to a climbing attitude and when the altimeter and vertical velocity show a definite rate-of-climb proceed with the normal after takeoff checklist. Fly clear of the runway as soon as practicable. In the accomplishment of a go-around from the approach condition at light gross weight, application of MAX AB on both engines will result in a significant nose-up pitching moment. The forward stick movement to counter the induced nose-up moment, plus the normal forward stick required to maintain level flight as the aircraft accelerates, results in a large forward stick deflection. Forward stick trim authority may not be sufficient to correct this nose-up tendency, and forward control stick application may be required. However, adequate longitudinal control is available to maintain level flight.

CLOSED PATTERNS.

Closed traffic patterns are normally flown in clean configuration at 250-300 knots by initiating a smooth climbing turn to a point abeam intended touchdown, where aircraft configuration for landing is established.

TAXI-BACK LANDINGS.

When accomplishing a taxi-back landing, do not turn off the runway short of the end if braking requirements cause the normal brake energy limits in Section V (18 million foot pounds) to be exceeded. The full runway length should be used if excessive braking would be required to turn off sooner. This will reduce heat buildup in the brakes and insure maximum braking capability for subsequent operations.

CAUTION

Have ground crew check brake temperature prior to setting auxiliary parking brake. If the temperature is acceptable to the bare hand, the auxiliary parking brake may be set. The "Taxi-Back Checklist" will be accomplished after clearing the runway. When a seat change is required, the change sequence is immaterial. During the seat change, ground interphone communications will be established. When both stations are being changed, a responsible individual will occupy the first vacated seat until the other seat change is completed. Extreme caution must be exercised throughout the maneuver. Engines should remain at IDLE. Personnel will secure loose equipment to prevent its ingestion into an engine. If the forward equipment hot lamp lights insure that the area in front of either engine is clear, then advance engine rpm to 80 percent. When the lamp goes out, retard the throttle to IDLE and complete the seat change. If the lamp does not go out, refer to "Caution Lamp Analysis," Section III.

Note

Items preceded by an asterisk are accomplished only if a seat change is required.

1. Nose wheel steering—Engaged.
N 2. Radar function knob—STBY.
N 3. Nav mode select pushbutton—TAS/D/A deselected.
4. Radar altimeter—OFF.
5. Landing and taxi lights switch—OFF.
6. Ground roll spoiler switch—OFF.
7. Pitot/probe heater—OFF/SEC.
N 8. IFF master control knob—STBY.
*B 9. Ejection handle and center beam safety pins—Installed.
* 10. Ground communications—Established.
* 11. Seat changed—Accomplished.
*B 12. Ejection handle and center beam safety pins—Removed.
* 13. Remove interphone and chocks—Chocks removed, disconnecting interphone (GO).
14. Wings, flaps, and slats—Set for takeoff.
    Check the surface position indicator for selected wing, flaps, and slat settings.
15. Speed brake—IN.
16. Ground roll spoiler switch—BRAKE.
17. Radar altimeter—As required.
18. Takeoff trim—Set.
B 19. Flight instruments and radios—Set for takeoff.
B 20. Canopies—Closed and latched, warning lamp out.
B 21. Canopy latch handle lock tabs—Flush.
B 22. Warning and caution lamps—Checked.
B 23. Oxygen—As required.
B 24. Takeoff data—Checked.
    Determine the nozzle/EPR values for takeoff. Rotation speed will be the final approach speed used for the previous approach.
N 25. Attack radar—As required.
N 26. IFF master control knob—As required.
N 27. Nav mode select pushbutton—As required.
28. Pitot/probe heater—Heat.
B 29. Lower helmet visor—As practical.

Note

Proceed with "Takeoff Checklist." If aircraft is to remain in closed traffic accomplish "Transition Checklist" after takeoff.

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AFTER LANDING. (NAV READS)

CAUTION

- To prevent damage to the canopy, do not open canopy with cabin pressurized. Prior to opening canopy, check that cabin pressure altimeter agrees with field elevation. If cabin is pressurized, place the pressurization selector switch to DUMP prior to opening canopy. (Equipment cooling is not affected with this switch in DUMP.)
- At light gross weights or with external stores, sweeping the wings full aft may establish an aft center-of-gravity condition resulting in full nose strut extension and free castering of the nose wheel.

1. Nose wheel steering—Engage.
2. Pitot/probe heater—OFF/SEC.
N 3. Radar function knob—STBY.
N 4. Nav mode select pushbuttons—TAS/D/A deselected.
N 5. HF radio—OFF.
6. Radar altimeter—OFF.
7. Landing and taxi light switch—OFF.
8. Ground roll spoiler switch—OFF.
9. Flap/slat handle—As required. (Normally extended)
    If slats are retracted, place rudder authority switch to FULL to insure full nose wheel steering.
N 10. IFF master control knob—OFF.
N 11. Weapons bay door control switch—OPEN. (As required)
~~N 12. Anti-collision lights switch—OFF.~~
B 13. Crew module ejection handle and center beam safety pins—Installed.

Note

- The ejection handle safety pins provided must be inserted center console outboard to preclude interference of the pins with seat adjustment.
- Destruct panel lockout pin installed if previously removed.

14. Engine feed selector knob—OFF.

ENGINE SHUTDOWN. (NAV READS)

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1. Wheels—Chocked. (GO)

1A ANTICOLLISION LT-OFF

2. Wing sweep handle—As required.
3. Flap/slat handle—As required.
4. **N** Function select knob—OFF.
5. Aerial refuel switch—OPEN. (If used)
   The engine feed selector knob must be in AUTO or BOTH before the air refueling receptacle will open.
6. Applicable throttle—OFF.

Note

The flight control system computers operate on 115 volt ac power from the essential ac bus. The essential ac bus is, in-turn, normally fed by the left generator. An interruption of power to the essential ac bus, such as loss or shutting down of the left generator or switching from left generator to external power will cause a mild shifting of the flight controls. This may also be accompanied by stick movement. Usually this will be felt as a mild air frame disturbance and should not be cause for concern.

7. Dampers—OFF.
8. Hydraulic pressure—Checked.
   Check for 2950 to 3250 psi indication.
9. Power flow indicator—Check TIE.
10. Remaining throttle—OFF.

Note

Do not move the control stick after shutting down the last engine. To do so will invalidate the following horizontal tail droop check.

11. Horizontal tail droop check—Completed.

WARNING

If both horizontal stabilizers do not droop (symmetrically or asymmetrically) within 60 seconds, a malfunctioning horizontal stabilizer servo valve is indicated, which will require corrective action prior to next flight.

12. Emergency generator—Checked.
    The emergency generator-indicator lamp will light momentarily as the last engine driven generator disconnects from the ac buses. The lamp will go out when hydraulic pressure driving the emergency generator is depleted.
13. **B** All switches and controls—Off, normal or safe.

WARNING

If the oxygen lever is left on and the regulator is set to EMER, liquid oxygen may flow through the regulator, creating a potentially hazardous situation.

POSTFLIGHT.

1. External stores jettison A, jettison B and nuclear master circuit breakers—Out. (Bombs/missiles aboard)
2. Ground safety locks and safety pins—Installed. (GO)
   Pilot must insure maintenance personnel have installed all ground safety locks and pins prior to departing. If qualified personnel are not available, locks and pins will be installed by aircrew.

Note

Ground safing procedures will be performed by aircrew if qualified MMS personnel are not available. (See ground safing procedures, this section.)

3. Ground safing procedures—Performed. (If applicable)
4. Bomb/missile discrepancies—Reported.
5. Applicable forms—Completed.

ALERT PROCEDURES.

When tactical units are required to maintain aircraft on alert for minimum time scramble, the alert procedures herein will be used in conjunction with the integrated preflight procedures contained in Section II of this manual. Use of these checklists provides for "Preflight" of an EWO configurated aircraft, "Cocking" the aircraft for scramble, "Minimum Reaction," and "Daily Alert Preflight" of a cocked aircraft.

AIRCRAFT ACCEPTANCE.

Note

If it is necessary to perform an acceptance check prior to EWO configuration, accomplish acceptance procedures as indicated, however, do not use "Cocking" procedures, Accomplish "After Landing," "Engine Shutdown," and "Postflight" checklists prior to releasing aircraft to maintenance for EWO loading. Normal aircraft acceptance must then be accomplished when EWO loading is complete.

After maintenance personnel have declared the aircraft to be EWO configured and ready to be placed on alert, the alert crew will continue the acceptance check which consists of accomplishing the following:

1. Before Exterior Inspection.
2. Exterior Inspection.
3. Stores Station Inspection.
4. Interior Inspection.
5. Before Starting Engines.
6. Starting Engines.
7. After Engine Start.
8. Before Taxiing.
   If the aircraft will not be moved prior to accomplishing the "Cocking" checklist, the "Before Taxiing" checklist need not be accomplished.
9. Penetration Aids Self Test Procedure.

After completing the acceptance preflight, and at required time, the alert crew will place the aircraft on alert in the cocked configuration by accomplishing the "Cocking" checklist:

SECURITY.

Entrance to the designated "NO LONE ZONE" of a cocked aircraft will be only upon approval of the assigned pilot. Procedures for access to the weapon system will be in accordance with command directives.

DAILY PREFLIGHT (AIRCRAFT ON ALERT LINE).

The daily alert preflight will be accomplished once each 24 hours by the assigned alert crew using the "Daily Alert Preflight" checklist. If an alert is sounded while the daily preflight is being accomplished, the aircraft will be completely recocked prior to attempting scramble procedures.

MAINTENANCE WHILE ON ALERT.

Maintenance may be performed without uncocking provided force timing is not degraded, power is not placed on the aircraft, access to the cockpit or weapon bay is not required and no electrical component is involved. If a requirement exists to defuel, the aircrew will uncock the aircraft using the "Uncocking" checklist. When the aircraft has been uncocked for maintenance/defueling and the work is completed, the "Exterior Inspection," "Stores Station Inspection" and "Power-Off Interior Inspection" will be accomplished prior to performing the "Cocking" checklist: Normal servicing requirements for water, oxygen, hydraulic or pneumatics, which do not require access to the cockpit or weapon bay may be accomplished on a cocked aircraft.

CREW CHANGEOVER PREFLIGHT PROCEDURES.

When a crew is replaced but the aircraft is to remain on alert, the new crew will accept the aircraft by accomplishing the "Stores Station Inspection" (starting with "Bomb/Missile Preflight") and "Daily Alert Preflight" checklist.

SCRAMBLE.

Aircrews will use the appropriate "Scramble" and "Takeoff" checklists when the execution order is given. Bold face items in the "Scramble" checklists are the minimum requirements for an EWO launch; however, all items should be accomplished if time and conditions permit. Applicable items of the checklist may be accomplished while taxiing; however, extreme caution must be used to insure safe operation. After takeoff, review applicable checklists to insure completion of all items. Normal flight manual procedures apply when airborne. After leaving the runway on moving exercises, accomplish the "After Landing" checklist and, after reaching the alert parking area, recock the aircraft using the "Cocking" checklist.

POWER-ON POSTURE.

If a "Power-On" posture is directed during a "Power-Off" scramble, the crew should complete the "Power-Off Scramble" checklist prior to accomplishing the "Power-On Cocking" checklist.

DAILY ALERT PREFLIGHT.

A generalized visual inspection of the aircraft will be accomplished to check for overall condition. Specific attention should be directed toward checking for damage, leaks, and area cleanliness.

Exterior Inspection.

B 1. External bomb/missile preflight—Accomplished. (Crew changeover)
B 2. Bay door interlock switch—SAFE. (If required)
B 3. Bay door lockpin—Installed. (If required)
B 4. Internal bomb/missile preflight—Accomplished. (Crew changeover)

WARNING

- The bay door lockpin must be installed and the bay door interlock switch positioned to SAFE prior to weapon bay entry.
- Insure weapon bay door area is clear of equipment and personnel prior to door actuation.

Accomplish the following if weapon bay doors are closed:

a. Power Off Preflight (Both)—Accomplished.
b. External Power—On.
c. Weapon bay door—Open.
d. External power—Off.
e. Internal bomb/missile preflight—Accomplished.
f. External power—On.
g. Weapon bay door—Closed.

Power Off Preflight. (Both)

Note

To prevent missile moisture accumulation on the AGM-69 missile loaded aircraft, delay the supply of ground cart pneumatic pressure to the aircraft until ready to begin "Power On Preflight (Both)" checklist.

1. All servicing—Complete. (GO)

B 2. CSSC indicator windows—Checked "A."

Note

Cease all activity and request CSS custodians (through the command post) if any CSSC indicator window is found set other than "A."

3. Nuclear consent switch—OFF, guard down, and sealed.
4. Radar altimeter control knob—CCW.
5. Engine feed selector knob—OFF.
6. Fuel transfer knob—OFF.
7. TFR channel mode selector knobs (2)—OFF.
8. UHF radios (2)—OFF.
9. TACAN—OFF.

N 10. Radar function knob—OFF.

N 11. IFF master control knob—OFF.

N 12. DCU-137/A control panel:

a. Control lever—OMS, sealed.
b. Option select switch—OFF.
c. Monitor and release knob—OFF.
d. Class III command switch—OFF.

N 13. SRAM cooling switch—OFF.

N 14. AGM-69A control and display panel:

a. Power switch—N.
b. Class switch—N.
c. Missile switch—N.
d. Train switch—OFF.
e. RHAW/RDR mode switch—N.
f. ARH/INERT mode switch—INERT.
g. Select and monitor knob—OFF.
h. OTL Operational test launch switch—N. (If installed)

N 15. Stores control panel:

a. Release enable switch—INHIBIT.
b. Master switch—OFF.
c. Delivery mode knob—OFF.
d. Selector mode knob—OFF.
e. Bay door control switch—As required.

WARNING

If the position of the bay door control switch is not in agreement with position of the weapons bay doors, the doors may actuate to the commanded position when hydraulic and/or electrical power is applied to the aircraft.

N 16. Function select knob—OFF.

Power On Preflight. (Both)

Note

If the engines are to be started or rotated, turn the ground roll spoiler switch OFF to prevent spoiler extension. Return the switch to BRAKE before leaving the aircraft.

1. Battery, external power switches and cooling air—ON and connected.

B 2. Oxygen pressure and quantity—Checked.

B 3. Fuel quantity indicators—Check.

a. Fuel quantity indicator test button—Depress and check:
   (1) Forward and aft tanks—2000 (±400) pounds.
   (2) Select tank—2000 (±100) pounds.
   (3) Total fuel—2000 (±1250) pounds.

4. Engine feed selector knob—FWD, AFT, then AUTO.
   Place the engine feed selector knob to FWD, AFT, then AUTO. Check that the appropriate fuel pump low pressure indicator lamps (six) light and go out and that the L and R FUEL pressure caution lamps go out.
5. Fuel transfer knob—AUTO.
   Hesitate at each position containing fuel and check that fuel pump low pressure indicator lamp blinks and goes out.

B 6. UHF radio—Checked.

B 7. Warning and caution lamps—Checked.

N 8. Coded switch set controller (CSSC):

Note

Cease all activity and request CSS custodians (through the command post) if the ENABLE lamp lights at any time other than during the lamp test button check. For other abnormal indications, refer to "CSS Malfunction Analysis," Section III.

a. Operate/monitor switch—MON, DISEN lamp lighted.
b. Lamp test button—Depressed.
c. Sum code —Set.
d. Operate/monitor switch—OPER.
e. CODE and DISEN lamps—Lighted.
f. Operate/monitor switch—MON. (Momentarily)

Note

System status (enable/disenable)may be verified at any time by holding the operate/monitor switch in MON and observing DISEN and ENABLE lamp indications.

g. CSSC indicator windows—Set all "A"s.

N 9. Stores control panel:
a. Store present lamps—Checked.
Check that store present lamps are lighted and displaying the proper store identification at each loaded station.
b. Master switch—ON.
c. CPU test/enable switch—ENABLE (GO).
If electrical power is interrupted, either by turning the master switch to OFF or removing ground power, the enable relay will deenergize. To reenergize, ground power must be available, the master switch ON, and the CPU test/enable switch momentarily actuated to ENABLE.
d. Selector mode knob—NUC WPN.
e. Test button—Depressed. (Bombs)
Check station select lamps lighted for all bomb loaded stations, out for all others.
f. Selector mode knob—OFF.
g. Master switch—OFF.

N 10. DCU-137/A control panel:
a. Option selector switch—MON.
b. Monitor lamps (each nuclear loaded station) —Checked.
Rotate monitor and release knob to each nuclear loaded station and check lamp indications: SAFE lamp lighted, Enable lamp (B-61 or PAL B-43/B-57 only), all other lamps out.
c. Monitor and release knob—OFF.
d. Option select switch—OFF.

B 11. Bay door lockpin—Removed. (GO)

B 12. Bay door interlock switch—NORMAL, cover closed. (GO)

13. Battery, external power switch, and cooling air —OFF.

14. Radar altimeter control knob—On.

15. TFR mode selector knob (2)—STBY.

16. UHF radios (2)—BOTH, channel selector knobs set.

17. TACAN—T/R, channel set, course selector set.

N 18. Radar function knob—STBY.

N 19. IFF master control knob—STBY.

N 20. Function select knob—GND ALIGN.

B 21. Personal gear—Arranged.

B 22. Combat mission folder container—Checked secure.

B 23. External B-43 plenum block covers—Installed. (If required)

COCKING.

This checklist prepares the aircraft for "Power Off Scramble," and is accomplished when placing aircraft on alert or recocking after uncocking.

Note

When the aircraft is uncocked for maintenance/defueling, accomplish the "Exterior Inspection," "Stores Station Inspection," "Interior Inspection Power-Off," and asterisked items of the "Interior Inspection Power-On" checklists prior to recocking the aircraft.

1. Auxiliary/parking brake—Pulled.

CAUTION

Do not perform this step if brakes are overheated.

2. Ground jettison switch—OFF, guard down. (If installed)

3. Wheels—Chocked. (GO)

N 4. INS alignment—Accomplished. (If required)

Note

- If aircraft was moved prior to align lamp flashing, a complete gyrocompass alignment must be accomplished prior to completing the "Cocking" checklist.
- Placing the function select knob to NAV momentarily after the gyrocompass alignment will improve the subsequent stored heading alignment.

N 5. INS ground align knob—OFF.

N 6. Function select knob—OFF.

N 7. Ejection handle and center beam safety pins—Installed.
8. Wing sweep handle—Set for takeoff.
9. Wing sweep handle lock controls—On.
10. Flaps/slats—As required, confirmed. (GO)
Operations where aircraft are exposed to the elements may require the flaps/slats to be retracted to minimize corrosion and prevent accumulation of ice and snow in flap/slat wells.
11. Takeoff trim—Checked.
N 12. Weapon bay doors—As required.
Weapon bay doors should be closed if B-43 weapons are carried in the weapon bay; otherwise open or closed as required by climatic conditions.
13. Left throttle—OFF.
14. Hydraulic pressure—Checked. (2950-3250 psi)
15. Engine ground start switch—OFF.
16. Cartridge—Installed. (If required) (GO)
Cartridge installation must be performed at this time if external starting air is not available; otherwise, cartridge installation may be delayed until after right engine shutdown.

WARNING

The pilot will verbally confirm with the ground observer that the left throttle is OFF and the engine ground start switch is OFF prior to cartridge installation.

17. Right throttle—OFF.
If a starter cartridge is not installed after left engine shutdown, insure that external air is available for immediate restart prior to shutting down right engine. (Air running but not connected)
18. Emergency generator—Checked, switch AUTO.
Check that the emergency generator lamp lights momentarily as the last engine driven generator disconnects from the ac buses. Check the lamp out when hydraulic pressure driving the emergency generator is depleted.
19. Exernal power switch and battery switch—OFF, cartridge installed. (If required) (GO)
20. Auxiliary/parking brake handle—In.
B 21. Oxygen control levers—OFF.
22. Air conditioning control panel:
a. Temperature control knob—As desired.
b. Air source selector knob—BOTH.
c. Mode selector switch—AUTO.
d. Pressurization selector switch—NORM.
e. Air flow selector switch—NORM. (If installed)
f. Exchange exit air control switch—OVERRIDE.
B 23. Communications panel—Set.
24. Auto TF switch—OFF.
25. Flight control system switch—NORM.
26. Rudder authority switch—AUTO.
27. Auxiliary pitch trim switch—STICK.
28. Speed brake switch—IN.
29. Anti-skid switch—ON.
30. Ground roll spoiler switch—BRAKE.
31. Flap/slat switch—NORM.
32. Flight control disconnect switch—NORM, cover down.
33. Flight instruments reference select switch—PRI.
34. Landing/taxi lights switch—OFF.
35. Utility hydraulic isolation switch—NORM.
36. Instrument systems coupler mode selector knob—As desired.
37. Optical display system mode select knob—CMD.
38. Radar altimeter control knob—ON.
39. Engine/inlet anti-icing switch—AUTO.
40. Pitot/probe heater switch—OFF/SEC.
41. Windshield wash/rain removal selector switch—OFF.
42. AFRS compass mode selector knob—SLAVED and lat set.
43. Hemisphere selector switch—As required.
44. Emergency generator/cutoff pushbutton — IN and safetied.
45. Generator switches (2)—RUN.
46. Fuel dump switch—OFF.
47. Air refueling switch—CLOSE.
48. Fuel tank pressurization selector switch — AUTO.
49. Engine feed selector knob—AUTO.
50. Fuel transfer knob—AUTO.
51. Spike control switches (2)—NORM.
52. Manual UHF command radio frequencies—Set.
B 53. UHF radios—BOTH, channel selector knobs set.
54. TACAN—T/R, channel set, course selector set.
55. ILS—OFF.
56. Panel and flood lights—Set.
73-6 N 57. Anti-collision lights—~~On~~ OFF
N 58. Position lights—BRT and STEADY.
N 59. Formation lights—BRT.
N 60. Fuselage lights—On.
N 61. Radar transponder control panel—Checked.
• Encode knob—As briefed.
• Power knob—OFF.
• Decode knob—As briefed.

N 62. Radar function knob—STBY.

N 63. RHAW system power/audio knob—OFF.

N 64. Navigation display unit:

a. *Fix mode selector knob*—OFF.

b. Nav mode select pushbutton—I only.

N 65. Sequence number set wheels—Set 01.

N 66. IRRS function selector knob—OFF.

N 67. External power—Checked OFF.
Navigator must insure that external power is off prior to accomplishing remaining items.

N 68. *Computer control unit:*

a. Function select knob—GND ALIGN.

b. Indicator lighting control knob—Set.

c. Test select knob—NORM.

d. General navigation computer switch—GNC.

e. Weapons delivery computer switch—WDC.

f. Astrocompass pushbutton—Selected.

g. Doppler radar pushbutton—Selected.

h. INS ground align knob—STRD HDG.

N 69. IFF master control knob—STBY.

N 70. IFF code selector knobs—As briefed.

B 71. Circuit breakers—In.

B 72. Personal gear—Arranged.

B 73. Combat mission folder container—Checked.

74. Battery switch—OFF.

B 75. Canopies—Checked.

76. External power cart — OFF, not disconnected. (If required) (GO)

77. Ground safety pins and safety locks—Removed.

L 78. External B-43 plenum block covers—Installed. (If required)

CAUTION

Insure that B-43 plenum block cover streamers are not hanging within danger area around inlet ducts.

79. Climatic covers—Installed. (If required)

POWER-OFF SCRAMBLE.

Note

This checklist is used for EWO and training launch of aircraft from cocked configuration. All items of the "Power-Off Scramble" checklist will be accomplished for a training launch. BOLD FACE items are the minimum requirements for an EWO scramble takeoff, however, if time permits, all items should be accomplished.

The scramble procedure is a coordinated effort by both crew members and the ground crew. During these procedures, the pilot must be alert for signals from the ground observer. If assistance is needed, the taxi lights will be flashed to signal the ground observer to connect the interphone.

BOTH:

1. **EXTERNAL B-43 PLENUM BLOCK COVERS — REMOVED. (IF REQUIRED)**

2. **CLIMATIC COVERS — REMOVED.**
Flight crew will insure that all climatic covers are removed.

PILOT:

1. **BATTERY AND EXTERNAL POWER SWITCHES—ON.**

Note

If engine start is not required, accomplish the checklist appropriate for directed posture.

2. **AUXILIARY/PARKING BRAKE — PULLED.**

3. **ENGINE GROUND START SWITCH — CART.**

4. **LEFT THROTTLE — START POSITION.**
Advance throttle to IDLE immediately.

5. Oxygen—ON/100 percent.

6. **HYDRAULIC LOW PRESSURE CAUTION LAMPS — OUT.**

7. **LEFT GENERATOR SWITCH — START, (PAUSE) RELEASE TO RUN, CAUTION LAMPS OUT.**

8. **CANOPY HATCH — CLOSED AND LATCHED, WARNING LAMP OUT.**
Closing of the pilot's canopy hatch is the signal for the ground observer to remove electrical connections, ground static wires and chocks.

9. **CANOPY LATCH HANDLE LOCK TAB — FLUSH.**

10. **ENGINE GROUND START SWITCH — PNEU.**

11. **LEFT ENGINE — 85 PERCENT.**

12. **START RIGHT ENGINE.**

13. **FLAP/SLAT — SET FOR TAKEOFF.**

14. **TAKEOFF TRIM — SET.**

15. *Hydraulic pressure indicators—2950-3250 psi.*

16. **RIGHT GENERATOR SWITCH—START, (PAUSE) RELEASE TO RUN, POWER FLOW INDICATOR NORM.**

17. Electrical power and air conditioning—Normal.

73,6 18. **TAXI LIGHT — ON.**

N 19. **READY TO TAXI — CONFIRMED.**

19A ANTI COLLISION LT - ON

20. **AUXILIARY/PARKING BRAKE — IN.**

21. **NOSE WHEEL STEERING – ENGAGED, INDICATOR LAMP LIGHTED.**
22. **BRAKES – CHECKED.**
23. Personal gear—Connected.
24. **AFRS SYNCHRONIZATION INDICATOR – NULLED.**
25. **FLIGHT INSTRUMENTS – CHECKED.**
26. **WARNING AND CAUTION LAMPS—CHECKED.**
27. **GROUND JETTISON SWITCH—ARM. (LAUNCH ONLY)**
28. **PITOT/PROBE HEATER SWITCH – HEAT.**
29. Instruments—Checked and set.
30. Radio call—Completed.
31. **TAKEOFF DATA – REVIEWED.**
32. **TAKEOFF TRIM/FLAPS AND SLATS—CHECKED.**

Note

Proceed with "Takeoff" checklist.

NAVIGATOR:

1. Oxygen—ON/100 percent.
2. **CANOPY HATCH – CLOSED AND LATCHED.**
3. **CANOPY LATCH HANDLE LOCK TAB – FLUSH.**
4. Personal gear—Connected.
5. Ejection handle and center beam safety pins—Removed.
6. **IFF MASTER CONTROL KNOB – AS BRIEFED.**
7. INS align indicator lamp—Lighted.

Note

- If align lamp is lighted, it is possible to use the inertial navigation mode prior to full warm up (align lamp flashing); however, degraded accuracy will result.
- Do not delay takeoff for ground alignment. If time does not permit ground alignment, accomplish an inflight alignment.

8. Inertial nav mode—Check selected.
9. Align lamp—Flashing.
   If aircraft is to be moved to improve posture, delay taxiing if possible, until align lamp is flashing to improve system accuracy for subsequent alignments.
10. **FUNCTION SELECT KNOB – NAV.**
11. **WEAPON BAY DOOR—CLOSED.**
12. Automatic sequencing—Initiated.
13. **TAKEOFF DATA – REVIEWED.**

Note

Proceed with "Takeoff" checklist.

POWER-ON COCKING.

This checklist prepares the aircraft for scramble from "Power-On Posture" and assumes previous accomplishment of normal "Cocking" checklists. It is also used to cock the aircraft for a "Power-On Posture" that is entered after accomplishing the "Scramble" checklist.

1. Auxiliary/parking brake—Pulled.
2. Ground jettison switch—OFF.
3. Ejection handle and center beam safety pins—Installed.
4. Left throttle—OFF.

N 5. INS alignment—Accomplished. (If required)
   If aircraft was moved prior to flashing align lamp, a complete gyro compass alignment should be accomplished prior to engine shutdown if time permits.

Note

Placing the function select knob to NAV momentarily after the gyrocompass alignment will improve the subsequent stored heading alignment.

N 6. INS ground align knob—OFF.
N 7. Function select knob—OFF.
N 8. INS ground align knob—STRD HDG.

9. Ground connect electrical power cart — Connected. (GO)
10. External power switch—ON.
11. Engine ground start switch—OFF.
12. Cartridge—Installed. (If required) (GO)
    Cartridge installation must be performed at this time if external starting air is not available; otherwise, cartridge installation may be delayed until after right engine shutdown.

WARNING

The pilot will verbally confirm with the ground observer that the left throttle is OFF and the engine ground start switch is OFF prior to cartridge installation.

13. Right throttle—OFF.
    If a starter cartridge is not installed after left engine shutdown, insure that external air is available for immediate restart prior to shutting down right engine. (Air running but not connected)
14. Cartridge—Installed. (If required) (GO)

B 15. External B-43 plenum block covers—Removed. (If required)

16. Taxi light switch—OFF.

17 Radar altimeter control knob—CCW.

18. Pitot/probe heater switch—OFF/SEC.

19. UHF #2 radio—OFF.

20. TACAN—OFF.

N 21. Radar function knob—OFF.

N 22. IFF master control knob—OFF.

23. Generator switches—RUN.

24. Engine feed selector knob—OFF.

25. Fuel transfer knob—OFF.

26. Anti-collision lights—OFF.

27. Position lights—OFF.

28. Formation lights—OFF.

29. Fuselage lights—OFF.

30. Ground air conditioner/heater—Connected. (If required) (GO)

B 31. Canopy hatches—Climatic.

32. Wheels—Chocked. (GO)

33. Auxiliary/parking brake—In.

Note

Climatic conditions should be monitored and takeoff data revised as necessary.

POWER-ON SCRAMBLE.

PILOT:

1. **AUXILIARY/PARKING BRAKE – PULLED.**
2. **ENGINE FEED SELECTOR KNOB – AUTO.**
3. **FUEL TRANSFER KNOB – AUTO.**
4. **ENGINE GROUND START SWITCH – CART.**
5. **LEFT THROTTLE–START POSITION.**
   Advance throttle to IDLE immediately.
6. Oxygen—ON/100 percent.
7. **HYDRAULIC LOW PRESSURE CAUTION LAMPS – OUT.**
8. **LEFT GENERATOR SWITCH–START, (PAUSE) RELEASE TO RUN, CAUTION LAMP OUT.**
9. **CANOPY HATCH – CLOSED AND LATCHED, WARNING LAMP OUT.**
   Closing of the pilot's canopy is the signal for the ground observer to remove electrical connections, air conditioner/heater, ground static wires, and chocks.
10. **CANOPY LATCH HANDLE LOCK TABS–FLUSH.**
11. **ENGINE GROUND START SWITCH–PNEU.**
12. **LEFT ENGINE–85 PERCENT.**
13. **START RIGHT ENGINE.**
14. **FLAP/SLAT–SET FOR TAKEOFF.**
15. **TAKEOFF TRIM–SET.**
16. Hydraulic pressure indicators—2950-3250 psi.
17. **RIGHT GENERATOR SWITCH–START, (PAUSE) RELEASE TO RUN, POWER FLOW INDICATOR NORMAL.**
18. Electrical power and air conditioning—Normal.
19. **TAXI LIGHT–ON.**

N 20. **READY TO TAXI–CONFIRMED.**

20A. Anti-collision light – on 73-6

21. **AUXILIARY/PARKING BRAKE–IN.**
22. **NOSE WHEEL STEERING – ENGAGED, INDICATOR LAMP LIGHTED.**
23. **FLIGHT INSTRUMENTS–CHECKED.**
24. **WARNING AND CAUTION LAMPS–CHECKED.**
25. **GROUND JETTISON SWITCH–ARM. (LAUNCH ONLY)**
26. **PITOT/PROBE HEATER SWITCH–HEAT.**
27. Instruments—Checked and set.
28. Radar altimeter control knob—On.
29. Radio call—Completed.
30. **TAKEOFF DATA–REVIEWED.**
31. **TAKEOFF TRIM/FLAPS AND SLATS–CHECKED.**

Note

Proceed with "Takeoff" checklist.

NAVIGATOR:

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~~1. **ANTI-COLLISION AND POSITION LIGHTS–ON AND STEADY.**~~

2. **FUNCTION SELECT KNOB – GND ALIGN.**
3. Formation lights—BRT.
4. Fuselage lights—On.
5. Oxygen—ON/100 percent.
6. **CANOPY HATCH – CLOSED AND LATCHED.**
7. **CANOPY LATCH HANDLE LOCK TAB – FLUSH.**
8. Ejection handle and center beam safety pins—Removed.
9. **IFF MASTER CONTROL KNOB – AS BRIEFED.**
10. INS align indicator lamp—Lighted.

Note

- If align lamp is lighted, it is possible to use the inertial nav mode prior to full warm up (align lamp flashing); however, degraded accuracy will result.
- Do not delay takeoff for ground alignment. If time does not permit ground alignment, accomplish an inflight alignment.

11. Inertial nav mode select pushbutton—Selected.
12. Align lamp—Flashing.
    Do not delay launch until align lamp is flashing; however, if changing ground position only, delay taxiing until align lamp is flashing if possible.
13. **FUNCTION SELECT KNOB – NAV.**
14. **WEAPON BAY DOOR—CLOSED.**
15. Selected sequencing—Initiated.
16. **TAKEOFF DATA—REVIEWED.**

Note

Proceed with "Takeoff" checklist.

UNCOCKING.

Accomplish this checklist when the aircraft is removed from alert status, or whenever maintenance is to be performed while the aircraft is on the alert line.

1. Anti-skid switch—OFF.
2. Ground jettison switch—OFF.
3. ODS mode select knob—OFF.
4. Radar altimeter control knob—CCW.
5. Engine feed selector knob—OFF.
6. Fuel transfer knob—OFF.
- **B** 7. UHF radios—OFF.
8. TACAN—OFF.
- **N** 9. Radar function knob—OFF.
- **N** 10. IFF master control knob—OFF.
- **N** 11. INS ground align knob—OFF.
12. External power switch—ON. (If required)
- **N** 13. Bay doors—As applicable:
    a. Bay doors—Clear. (GO)
    b. Bay door auxiliary switch—AUX.
    c. Bay door control switch—OPEN.
    d. Bay door interlock switch—SAFE. (GO)
    e. Bay door lockpin—Installed. (GO)
- **N** 14. Mission data—Destroyed. (If required)
15. External power switch—OFF. (If required)
- **N** 16. HSD classified data—Removed. (As required)
- **N** 17. Function select knob—OFF.
- **N** 18. General navigation computer switch—OFF.
- **N** 19. Weapons delivery computer switch—OFF.
20. Ground check panel — All switches OFF or NORM.
- **N** 21. External stores jettison A, jettison B, and nuclear master circuit breakers—Out. (Bombs/missiles aboard)
22. All interior and exterior lights—OFF.
23. Combat mission folder containers — Removed. (If required)
24. Ground safety pins and safety locks—Installed.
25. Pivot pylon jettison ground safety lockpins — Installed, LOCKED.
26. Internal/external bomb/missile rack ground safety pins and external fuel tank pylon ground safety pins—Installed.
27. Internal/external B-43 plenum block covers—Installed.

STRANGE FIELD.

If it is necessary to land at an airfield where normal ground support equipment or personnel are not available, the air crew will be responsible for performing or closely supervising the required aircraft servicing. There are several items which must be performed after engine shutdown, and additional items of servicing and inspection are required prior to takeoff. It is recommended that the air crew become familiar with the servicing procedures for all items listed on the Servicing Diagram, Section I. Engine starting is normally accomplish with gas turbine generator set A/M32A-60. The unit supplies engine starting air and ac power for the aircraft electrical systems. Alternate engine starting equipment consists of an MA-1A gas turbine as a source of air pressure with MD-3A, or MD-4, or the aircraft battery as a source of electrical power for ignition. Electrical power requirement for ground refueling, if power is deemed necessary, consists of an A/M32A-60, or either MD-3A or MD-4 as a substitute. The following check list supplements the normal operating procedures and includes items that would normally be accomplished by the ground crew.

AFTER SHUTDOWN.

1. Engine oil level—Checked.
   Check oil level indication on dipstick and determine quantity required to bring oil level to the 20 quart level or FULL MARK. Service with oil MIL-L-7808 F or later.

Note

The engine oil system must be checked within 15 minutes after shutdown in order to determine accurate consumption as variable amounts of oil can leak from tank into the gearbox over longer periods.

2. Hydraulic reservoirs—Checked.
   Check the utility and primary hydraulic reservoirs for specified accumulator preload and fluid level in accordance with placard.
3. Refueling—Accomplish. (As required)
   If high ambient temperatures (above 100 degrees) are anticipated, a full fuel load should not be taken on. Excessive fuel venting will

occur which may create a hazardous condition.

a. Single point refueling.

Note

- The lower engine access doors should be closed prior to ground refueling. The added fuel weight may preclude closing the doors after refueling.
- External electrical power may be connected during refueling if desired for monitoring instruments; otherwise, external power is not necessary.

(1) Aircraft and refueling equipment — Grounded.
Insure that the aircraft and all refueling equipment are statically grounded.

(2) Nose gear chocks—Removed.

CAUTION

Remove nose wheel chocks and work stands, compression of the nose wheel strut causes nose wheel movement which could result in structural damage if chocked.

(3) Precheck selector valves—REFUEL.

(4) Fueling hose ground cable—Connected.
Connect the grounding cable from the fueling hose to the aircraft.

(5) Ground refueling receptacle cap—Removed.

(6) Fuel nozzle—Connected to refueling receptacle.

(7) Start fuel servicing unit and open fuel nozzle.

(8) Precheck selector valves—PRI or SEC. (As applicable)
Within a few seconds after fuel flow is indicated, position all precheck selector valves to PRI or SEC as applicable. The fuel flow should drop to less than 10 gpm indicating that all primary valves have closed.

CAUTION

Do not allow fuel flow to the aft tank or wing tanks for more than a few seconds when the forward tank quantity is below 7500 pounds. To do so may cause a longitudinal unbalance and cause the aircraft to tip up.

Note

If fuel flow drops to 10 gpm or less, proceed to step 10. If fuel flow does not drop, determine which refuel valve has malfunctioned by reducing flow from servicing unit to a minimum and operate valves individually as follows. Select the aft tank valve to SEC and observe the flowmeter for 30 seconds, then select PRI. If flow did not drop below 5 gpm when SEC position was selected, repeat the test for the forward tank. If flow is not stopped when SEC position is selected for the forward tank, repeat the test for each wing by changing positions for the wing precheck selector valve located on the lower surface of each wing. The defective valve will be indicated by a drop of flow.

(9) Fuselage tank and weapon bay tank (if installed) precheck selector valves—REFUEL then SEC.
Individually rotate the fuselage tank and weapon bay tank (if installed) precheck selector valves to REFUEL and then to SEC while observing the flowmeter. Flow should rise while in the REFUEL position, indicating that the selected refuel valve has opened. The valve should then close when the SEC position is selected.

(10) Precheck selector valves—REFUEL.
Continue refueling operations.

(11) Position lights/stores refuel battery power switch—STORES REFUEL.
If external tanks are installed, place the position lights/stores refuel battery power switch to STORES REFUEL.

(12) Tank pressure gage—Monitor.
If pressure exceeds 3 psi, discontinue refueling operation and determine the cause. The tanks should be depressurized and air should flow from the vent during fueling.

Note

Fuel tanks are full and valves are closed when the flowmeter on the fuel truck falls to zero.

(13) Fuel nozzle—Closed.
At completion of refueling, close the fuel nozzle and stop the refueling truck pump.

(14) Fuel nozzle and grounding cable—Disconnected.

(15) Refueling receptacle cap—Installed.

(16) Single point refueling control access doors—Closed and latched.

(17) Position lights/stores refuel battery power switch — NORM. (If external tanks were fueled)

Note

Failure to return position lights/stores refuel battery power switch to NORM will produce drain on the battery when external electrical power is not connected.

b. Gravity refueling.

(1) Connect external power.

Note

External power is not required; however, a full reservoir tank will not be assured until after engine start unless forward feed is selected and fuel pumps operated for approximately 2 minutes with the forward tank at 4000 pounds or more.

(2) Aircraft and refueling equipment — Grounded.
Insure that the aircraft and all refueling equipment are statically grounded.

(3) Nose gear chocks—Removed.

CAUTION

Remove nose wheel chocks and work stands, compression of the nose wheel strut causes nose wheel movement which could result in structural damage if chocked.

(4) Fuel tank pressurization.
If tanks are pressurized, place the tank pressurization switch to AUTO to relieve pressure.

CAUTION

The vent tank is within the vertical stabilizer and extends near the top; therefore, if fuel has entered the vent tank a head pressure will exist. Extreme care must be exercised when removing the gravity refuel caps from any fuel tank. Loosen the cap slightly watching for signs of fuel flow prior to removing the cap.

(5) If the forward tank quantity is 4000 pounds or greater, place forward tank selection switch to forward feed and allow fuel pumps to operate for approximately 2 minutes to assure a full reservoir tank.

(6) Bay F-1 and F-2—Refueled.

Note

- Remove filler cap from bay F-1 and then bay F-2. If fuel seeps out as bay F-2 filler cap is loosened, do not continue removing cap as bay F-2 is full. Fill bay F-1 only. Otherwise, fill bay F-2 and then bay F-1.
- If forward tank initially had less than 4000 pounds, perform step 4 after the forward tank has been filled above 4000 pounds, and then continue filling.

(7) Gravity refuel the remaining tanks in the following order:
(a) Bay A-1
(b) Bay A-2
(c) Wing Tanks

Note

If a partial fuel load is required, the forward tank should contain 8200 pounds more fuel than the aft tank. Any fuel added to the wings shall be distributed equally between the wing tanks.

(8) Fuel filler caps—Secure.

c. Gravity refueling external wing tanks.
For servicing the external pylon tanks using gravity (overwing) refueling procedure, the fuel must first be serviced into wing tanks and then transferred into external pylon tanks. To service external pylon tanks proceed as follows:

(1) Fully service wing and fuselage tanks.
(2) Apply electrical power to aircraft.
(3) Position lights/stores refuel battery power switch—STORES REFUEL.
(4) Engine selector knob—OFF.
(5) Tank pressurization switch—OFF.
(6) Transfer selector knob—WING.

Note

- If the fuselage tanks are not full fuel will flow into the fuselage tanks and external tanks.
- Fuel will flow into all installed external tanks simultaneously.

(7) Position transfer selector knob to OFF when advisory lamps light steadily for pumps 7, 8, 9, and 10 or when desired amount of fuel has been transferred into external tanks.

(8) Electrical power—OFF.

(9) Repeat steps (1) thru (8) until external pylons are serviced with desired amount of fuel.

(10) Position lights/stores refuel battery power switch—NORM.

(11) Disconnect electrical power from aircraft.

POSTFLIGHT.

1. Exterior inspection—Complete.
   Follow route shown in figure 2-1. Make necessary entries in the Form 781.

Note

While performing the strange field postflight, and preflight, exterior inspections check for the following:

- Cuts, scratches, loose rivets and fuel leaks.
- All drain plugs for leakage.
- That all access doors and panels are secure.
- Tires for condition.
- Reservoirs and accumulators for proper servicing.
- Ground area around aircraft for cleanliness.

Aircraft is now ready for relaunch; however, if flight is terminated or takeoff substantially delayed, accomplish the following:

a. Canopies—Closed.
b. Ground locks—Installed. (If available)
c. Pitot cover—Installed. (If available)

DELAYED TAKEOFF.

If takeoff has been delayed for an extended time (over 12 hours), a normal exterior preflight should be accomplished following route shown in figure 2-1. The following systems should be checked and serviced as required, refer to the "Servicing Diagram," Section I. Upon completion, follow normal procedures Section II. Complete required Form 781 entries prior to takeoff.

1. Preflight and Form 781—Completed.
2. Liquid oxygen—Checked.
   Service with liquid oxygen MIL-O-27210, Grade B, Type II.
3. *Pneumatic pressure*—Checked.
   Pneumatic pressures should be checked for required pressure range specified for the ambient temperature. Service with Nitrogen: FS BB-N-411, Type I, Class I, Grade B, or Air: MIL-P-5518.
4. *Constant speed drive*—Checked.
   Check outboard sight gage on both left and right drive units. If oil is in the green band, no servicing is required. If servicing is required, proceed as follows. Service with oil MIL-L-7808.
   - Refill very slowly until oil level reaches the bottom of the green band. Shut off oil supply to avoid overfilling, and allow oil level to equalize. As much as 5 minutes may be required.
   - Repeat preceding step until oil level is stabilized in the green band.
5. Utility and primary hydraulic reservoirs — Checked.
   Check the utility and primary hydraulic reservoirs for specified accumulator preload and fluid level in accordance with instruction placard. If servicing is required, proceed as follows. Service with oil: MIL-H-5606.
   - Check the hydraulic reservoir pneumatic pressurization system for proper service. For pneumatic servicing requirements refer to "Servicing Diagram," Section I.
   - Position aircraft hydraulic hand pump selector valve to BRAKE and pump brake accumulators to 3100 psi pressure prior to servicing the utility reservoir.
   - Fill reservoir slowly until quantity gage indicates proper fluid level as shown on reservoir service placard.
   - Open reservoir air bleed valve (lower aft end of reservoir) sufficiently to bleed trapped air from the reservoir fluid chamber.
   - Check the reservoir quantity indicator for *proper fluid level.*
   - Repeat steps d through e until the reservoir is fully serviced and free of air.
6. Landing gear shock struts—Checked.
   Check nose landing gear shock struts and main landing gear shock struts inflated in accordance with strut instruction placard. Service with Nitrogen: FS BB-N-411, Type I, Class I, Grade B, or Air: MIL-P-5518.
7. Tires—Checked.
   Refer to figure 2-7.
8. Angle-of-attack and side slip probes—Checked for slot cleanliness and freedom of movement.

Tire Inflation Pressures (PSI)

DATE: 6 MARCH 1970

Aircraft Gross Weight (1000 Pounds)	*Main Gear*	*Nose Gear (22 x 6.6 — 10)*	*Nose Gear (21 x 7.25 — 10)*
69 AND BELOW	115-125	160-170	235-245
69-73	125-135	170-180	245-255
73-77	135-145	180-190	255-265
77-81	145-155	190-200	255-265
81-86	155-165	200-210	265-275
86-90	155-165	210-220	275-285
90-94	165-175	220-230	285-295
94-99	175-185	230-240	285-295
99-103	185-195	240-250	295-305
103-107	195-205	250-260	295-305
107-110	205-215	260-270	305-315
110 & ABOVE	215-220	270-275	315-320
OVERINFLATION PERMISSIBLE FOR ALL GROSS WEIGHTS BUT NOT TO EXCEED MAXIMUM SPECIFIED ABOVE.			

Figure 2-7.

AIRCRAFT EMERGENCY MOVEMENT CHECKLIST.

CAUTION

Pilot will ascertain from ground crew or form 781 that the aircraft status will allow ground movement.

STARTING ENGINE.

1. Connect external power and air or install cartridge—Accomplished.
2. Ground ignition cutoff switch—NORM.
3. Battery and/or external power switches—ON. (As applicable)
   Engine start may be accomplished using either battery or external power, or both.
4. UHF radios—ON and set.
5. Engine feed selector knob—AUTO.
6. Position lights—BRT and FLASH.
7. Auxiliary/parking brake—Pulled.
8. Engine ground start switch—PNEU or CARTRIDGE. (As applicable)
   Place the engine ground start switch to PNEU when starting the engines with external starter air or to CARTRIDGE for a cartridge start.
9. Throttle—Start, then IDLE:
   a. On a cartridge start, advance the applicable throttle to IDLE immediately.
   b. On a pneumatic start, advance the applicable throttle to IDLE after engine rpm reaches 17 percent.
10. Engine instruments, caution lamps and hydraulics—Checked.
11. Engine ground start switch—OFF.

Note

If engine ground start switch is not returned to OFF, nose wheel steering will be inoperative.

12. Generator switch—START (pause), release to RUN.

Note

If the generator caution lamp remains lighted, place the generator switch to OFF/RESET, hold to START (pause), then release to RUN.

13. Air refueling switch—CLOSE.
14. External power switch—OFF, external power and air units removed.
15. Rudder authority switch—FULL.

TAXIING.

734 1. Anticollision Lt - ON

1. A Auxiliary/parking brake handle—In.
2. Nose wheel steering—Engaged.
   Check that the nose wheel steering indicator lamp is lighted. Check engagement of nose wheel steering by slight movement of rudder pedals.
3. Brakes—Checked.
   Depress brake pedals and check for proper braking.
4. Hydraulic pressure — Checked. (2950 to 3250 psi)

ENGINE SHUTDOWN.

1. Wheels—Chocked.
2. Throttle—OFF.

BEFORE LEAVING AIRCRAFT.

1. All switches and controls—OFF, normal or safe.

BOMB/MISSILE MOVEMENT, PREFLIGHT AND CONFIGURATION.

For any bomb/missile movement (Ground Safing, Deployment/Dispersal/Recovery, Tactical Ferry or EWO Restrike) accomplish the normal "Stores Station Inspection (Both)" and the applicable checklist below.

Note

If any bomb/missile discrepancy is noted, cease all physical activity and call qualified personnel.

GROUND SAFING, DEPLOYMENT/DISPERSAL/ RECOVERY.

Note

- For a deployment/dispersal mission, bomb/missile configuration will be accomplished by MMS personnel and checked by the aircrew.
- For ground safing or a recovery mission (qualified MMS personnel not available), Bomb/missile configuration will be accomplished by the aircrew.

B-43 Bomb:

1. Ready/safe switch—SAFE.
2. Strike enable plug—Removed.

B-57 Bomb:

1. Ready/safe switch—SAFE.
2. Pylon access door (external)—Opened.
3. AMAC SPU power cable—Disconnected.
4. Wire rope assembly (pullout switch lanyard)—Disconnect. (Deployment/Dispersal/Recovery only)
5. Pylon access door (external)—Closed.

B-61 Bomb:

1. Ready/safe switch—SAFE.
2. Preflight selection panel door—Opened.
3. Strike enable plug—Removed.
4. Preflight Selection panel door—Closed.

AGM-69A:

1. Right forward equipment bay access door—Open.
2. Electrical connector (247P10) on CES—Disconnected.
3. Right forward equipment bay access door—Closed and secured.
4. SAF Prearm/Safe indicator—Checked "S".
5. Missile fins (internal)—Checked.
6. Tail Cone (external)—Attached.

EWO RESTRIKE (MMS PERSONNEL NOT AVAILABLE).

Note

To reconfigure the bomb/missile for EWO restrike after ground safing, accomplish the following steps during normal preflight.

B-43 Bomb:

1. Strike enable plug—Installed.

B-57 Bomb:

1. Pylon access door (external only)—Opened.
2. AMAC SPU power cable—Connected.
3. Wire rope assembly (pullout switch lanyard)—Connected.
   If only the bomb safing check has been completed, the lanyard will not have been disconnected.
4. Pylon access door (external only)—Closed.

B-61 Bomb:

1. Preflight selection panel door—Opened.

2. Strike enable plug—Installed.
3. Preflight selection panel door—Closed.

AGM-69A:

1. Right forward equipment bay access door—Open.
2. Electrical connector (247P10)—Connected to CES.
3. Right forward equipment bay access door—Closed and secured.

TACTICAL FERRY PROCEDURES.

For a tactical ferry mission, bomb/missile configuration will be accomplished by qualified MMS personnel.

All Bombs:

1. Ready/Safe switch—"S" (SAFE).
2. Strike enable plug—Installed.

AGM-69A:

1. SAF Prearm/Safe indicator—Checked "S."
2. Missile Fins (internal)—Checked.
3. Tail Cone (external)—Attached.

INTERIOR INSPECTION/INFLIGHT PROCEDURES.

Deployment/Dispersal/Recovery.

Note

Bomb/Missile monitor and control is not possible but a release may be accomplished by any method other than a normal launch for missile. Accomplish normal checklist procedures except the step addressing the DCU-137/A Control Panel, in "Interior Inspection (Power On)" and any prearming or bombing/launch procedure checklist. Application of system power for missiles is not required.

EWO Restrike.

Note

All normal aircrew procedures will be accomplished. Safety wires or seals broken as a result of a previous bomb/missile prearming need not be resealed.

Tactical Ferry.

Bomb/Missile monitor and control is not possible but a release may be accomplished by any method other than normal launch for missiles. Accomplish normal checklist procedures except the step addressing the DCU-137/A Control Panel, in "Interior Inspection (Power On)" and any prearming or bombing/launch procedure checklist. An uncommanded ejector rack unlock status will be indicated by the nuclear caution lamp. Application of system power for missiles is not required.

PREFLIGHT CHECK (NON-NUCLEAR).

Flight crew station time will normally be one hour before scheduled takeoff time. If the stores station inspection reveals a discrepancy, all physical operations will cease until qualified MMS personnel have determined the necessary corrective action to be taken.

BEFORE EXTERIOR INSPECTION.

1. Security guards posted. (If required)
2. Form 781—Checked.
   Pilot checks Form 781 for engineering status, discrepancies, stores configuration, and mission tape loading. He also notes fuel loading and distribution for comparison with scheduled fuel load and gages later during preflight.

EXTERIOR INSPECTION.

The exterior inspection is based upon the fact that maintenance personnel have completed all of the requirements of the Scheduled Inspection and Maintenance Requirements Manual for preflight and post flight; therefore, duplicate inspections and operational checks of systems have been eliminated except for those needed in the interest of flight safety. The flight crew should keep in mind that the exterior inspection performed by them is only a flight crew inspection of readily accessible items. Should the pilot wish information on non-accessible items, he should examine the "Preflight Inspection Record." Following the route shown in figure 2-1, check all surfaces for any type of damage; signs of fuel, oil, hydraulic or other fluid leaks that may have developed since the preflight inspection. Check hydraulic accumulators. Check all access doors and covers for security. Check that gravity fuel filler caps are flush. Check the angle-of-attack and side slip probes for slot cleanliness and freedom of movement. Check main landing gear uplock assembly for proper positioning as indicated by the red tip of the lock assembly being aft of the uplock roller guide.

1. Ground safety pins and safety locks—Removed. (As required)
   Those marked with asterisk, stow in aircraft.
   *a. Nose gear
   *b. Main gear
   *c. Arresting hook

2. External fuel tank pylon ground safety pins—Removed. (Stow aboard aircraft)

Note

- For normal operations, the speed brake/main landing gear door ground lock should be left installed until one engine has been motored or started. This will prevent safing of the door after the ground lock is removed.
- The stores station inspection and bomb preflight will be accomplished concurrently with the aircraft exterior inspection.
- The landing gear emergency system may be actuated by contact with the lever actuator located in the main wheel well on the left side. Exercise care when inspecting this area.

STORES STATION INSPECTION. (NAV)

External Bomb Stations:

1. MAU-12 bomb rack:
   a. Ground safety pin—Installed.
   †b. Inflight safety lockpin—Removed or installed (as applicable).
†2. Pivot pylon jettison ground safety lockpin—Installed, LOCKED, NON-NUCLEAR/NUCLEAR (as applicable).
3. General condition of munitions—Checked.
4. Pivot pylon jettison ground safety lockpin—UNLOCKED, removed. (Stow aboard aircraft)
5. BRU-3 bomb rack:
   a. Electrical safety pin—Removed.
   b. Mechanical safety pins—Removed.

Internal Bomb Stations:

WARNING

The weapons bay doors safety interlock switch will be in the SAFE position and the weapons bay door lockpin installed before entering the weapons bay.

1. Weapons bay doors interlock switch—SAFE.
2. Weapons bay doors lockpin—Installed.
3. MAU-12 bomb rack:
   a. Ground safety pin—Installed.
   †b. Inflight safety lockpin—Removed or installed. (As applicable)
4. General condition of bomb—Checked.
5. Bomb rack ground safety pin—Removed. (Stow aboard aircraft)

BEFORE ENTERING COCKPIT. (PILOT)

1. Ejection handle safety pins (2)—Installed.
2. Canopy center beam safety pins (3)—Installed.
3. Bilge pump lock pins—Stowed.
4. Emergency oxygen bottle pressure Check—1400 to 2500 psi.
5. All circuit breakers—In.
6. Ground check panel—Check.
   - Computer power switches (3)—ON.
   - CADC power switch—POWER.
   - Ground ignition cutoff switch—NORM.
   - Gyros power switch—GYROS.
   - Mach trim test switch—NORM.
   - Fire detect switches—NORM.
7. Publications—Checked.
8. Radio beacon set—ON or as applicable.

BEFORE ENTERING COCKPIT. (NAV)

1. Ejection handle safety pins (2)—Installed.
2. Canopy center beam safety pins (3)—Installed.
3. Survival equipment compartment covers (2)—Closed and sealed.
4. Crew module chaff dispenser control lever—As required.
   The lever should be ON over friendly territory and placed to OFF as directed by tactical requirements.
5. Quick rescue kit—Stowed. (If applicable)

INTERIOR INSPECTION.

Power Off. (Both)

1. Battery switch—OFF.
2. External power switch—OFF.
3. Cabin air distribution lever—Set.
B 4. Personnel equipment.
   a. Restraint harness and inertial reel—Connected and checked.
      Insure that the yoke of the restraint harness is adjusted firmly against the neck with head against headrest and sitting erect to allow full reel-in in the event of subsequent ejection. Check the condition of the restraint harness. Check operation of the inertia reel in the locked and unlocked position.
   b. Oxygen regulator—Installed.

CAUTION

Care must be taken so as not to damage valve port screens when connecting oxygen regulator to restraint harness and oxygen supply hose, or when connecting mask-hose to oxygen regulator. These screens are easily damaged by improper/careless handling, and inadvertently placing fingers on screens while performing any of the aforementioned tasks.

c. Oxygen mask and communication cord—Connected.

d. Oxygen lever—OFF, then ON.
Turn the oxygen lever OFF and inhale several times. Note that breathing becomes more difficult due to the restrictions of the antisuffocation valve. Also observe that the antisuffocation valve on the front of the regulator unseats with each inhalation, then turn the oxygen lever ON.

CAUTION

To prevent possible regulator damage, do not turn oxygen ON until dust cap has been removed from quick disconnect fitting and mask hose has been connected.

e. Oxygen regulator—Checked.
- Oxygen control knob—EMER.
Check that a positive pressure is felt in the mask and that the diluter valve does not move.
- Oxygen control knob—100 percent.
Inhale and check that the diluter valve does not move.
- Oxygen control knob—NORM.
Inhale and check movement of the diluter valve through the screen on the top of the regulator.

5. Air conditioning control panel:
   a. Temperature control knob—As desired.
   b. Air source selector knob—BOTH.
   c. Mode selector switch—AUTO.
   d. Pressurization selector switch—NORM.
   e. Air flow selector switch—NORM. (If installed)
   f. Exchange exit air control switch—NORM. (OVRD if external stores are installed)

B 6. Communications panel—Set.
7. Auto TF switch—OFF.
8. Control system switch—NORM.
9. Rudder authority switch—AUTO.
10. Throttles—OFF.
11. Speed brake switch—IN.
12. Anti-skid switch—ON.
13. Ground roll spoiler switch—OFF.
14. Flap/slat system selector switch—NORM.
15. Flight control disconnect switch—NORM, cover down.
16. Flight instrument reference select switch—PRI.
17. Landing/taxi lights switch—OFF.
†18. Nuclear consent switch—OFF, guard down. (If required)
19. Bombing timer—OFF.
20. Landing gear handle—DN.
21. Utility hydraulic system isolation switch — NORM.
22. Ground jettison switch—OFF, guard down.
23. Arresting hook handle—In.
24. Clock—Set.
25. Optical display system mode select knob—MAN.
26. Aiming reticle cage lever—Uncage.
27. Radar altimeter control knob—Full CCW.
28. Engine/inlet anti-icing switch—AUTO.
29. Pitot/probe heater switch—OFF/SEC.
30. Windshield wash/rain removal selector switch—OFF.
31. AFRS compass mode selector knob—Slaved and LAT set.
32. Hemisphere selector switch—As required.
33. Emergency generator indicator/cutoff pushbutton—In and safetied.
34. Emergency generator switch—AUTO.
35. Generator switches (2)—RUN.
36. Antenna select switches—As required.
37. Landing gear emergency (alternate) release handle—IN.
38. Fuel dump switch—OFF.
39. Air refueling switch—CLOSE.
40. Fuel tank pressurization selector switch—AUTO.
41. Engine feed selector knob—OFF.
42. Fuel transfer knob—OFF.
43. TFR channel mode selector knobs (2)—OFF.
44. Spike control switches (2)—NORM.
45. UHF #2—OFF.
46. TACAN—OFF.
47. ILS power switch—OFF.

N 48. Radar transponder control panel—Checked.
- Encode knob—As briefed.
- Power knob—OFF.
- Decode knob—As briefed.

N 49. UHF #1—OFF.

N 50. TFR scope panel—Checked.
- Polaroid filter control (2)—Full up.
- Tuning control knobs (4)—Full CCW.
- Range selector knob—E.

N 51. RHAW scope controls—Checked.
- Gate selector knob—N.
- Brightness/reticle intensity knob—CW.
- Sensitivity knob—Full CW.
- Memory control knob—Full CCW.
- Mode selector knob—As desired.
- View control knob—Full CCW.
- Scope filter—As desired.

N 52. RHAW threat display panel—Checked.
- Remaining disposable counter—Checked.
- Test knob—OFF.
- Power/audio control knob—OFF.

N 53. Attack radar scope panel—Checked.
- Beta switch—NORM.
- Sweep switch—NORM.
- Test switch—OFF.
- Range intensity knob—Midpoint.
- North orientation selector switch—As desired.
- Azimuth intensity knob—Midpoint.
- Bezel/range mark intensity knobs—Midpoint.
- Scope intensity knob—CCW.
- Range selector knob—15/5.
- Video/transmit tuning knobs—Midpoint.
- Sensitivity time control knobs—OFF.
- IF gain/antenna tilt knobs—Midpoint/detent.
- Photo mode selector switch—OFF.
- Magazine data slate/clock—Annotated and set.

N 54. Attack radar control panel—Checked.
- Mode selector knob—GND MAN
- Frequency control knob—AFC-1.
- Radar function knob—OFF.
- Present position correction switch—OUT.
- Antenna polarization switch—NORM.
- Side lobe cancellation switch—OFF.
- Fast time constant/beacon switch—OFF.

N 55. Navigation display unit:
a. Fix mode selector knob—OFF.
b. Nav mode select pushbuttons—I only.

N 56. IFF master control knob—OFF.

N 57. Store control panel:
a. Release enable switch—INHIBIT.
b. Master power switch—OFF.
c. RBS tone switch—OFF.
d. Delivery mode knob—OFF.
e. Selector mode knob—OFF.
f. Bay door control switch—Checked.
Check that the position of the bay door control switch is in agreement with the position of the weapons bay doors.

WARNING

If the position of the bay door control switch is not in agreement with position of the weapons bay doors, the doors may actuate to the command position when hydraulic and/or electrical power is applied to the aircraft.

g. Bay door auxiliary switch—NORM.
h. Station selector switches—All deselected.

N 58. SRAM cooling switch—OFF.

N 59. Computer control unit:
a. Function select knob—OFF.
b. Test selector knob—NORM.
c. Test switch—NORM.
d. General navigation computer switch—GNC.
e. Weapons delivery computer switch—WDC.
f. INS ground align knob—G/C.

N 60. HF radio mode selector knob—OFF.

N 61. CMDS control panel:
a. Arming switch—SAFE.

WARNING

Placing the arming switch and mode selector knobs to any other position than SAFE or OFF could result in inadvertent dispensing of explosive chaff and flares.

b. Mode selector knobs (3)—OFF.

N 62. ECM control knobs (3)—OFF.

N 63. IRRS control panel:
a. Function selector knob—OFF.
b. Azimuth blanking control knob—AUTO.
c. Elevation blanking control knob—AUTO.

Power On. (Both)

1. Battery switch—ON.
TIT power-off flags out of view indicates battery is on.

*2. External power switch—ON. (If applicable)
If external power is to be used, place the external power switch to ON and check that the electrical power flow indicator displays TIE.

Note

If the engines are to be started using battery power, the following "Power On" checks must be delayed until the engines are running.

*B 3. Seat and headrest—Adjusted.

*N 4. Circuit breakers:

a. External stores jettison A and B circuit breakers—OUT.

b. All others—In.

5. Central air data computer test switch—LOW and depress master test button and check.

a. Angle-of-attack indexer—High speed symbol.

b. Angle-of-attack—7.0 (±0.75) degrees.

c. Mach number—0.40 mach.

d. Indicated airspeed—153 (±11) KIAS, OFF flag in view.

e. Altitude vertical velocity—(±100) feet per minute.

f. Altimeter (with 29.92 set)—2000 (±130) feet, OFF flag in view.

g. Central air data computer true airspeed—158 (±13) TAS.

h. CADS caution lamp—Lighted.

Note

When the CADC test switch is used in conjunction with the master test switch, the function select knob or the INS ground align knob should be in the OFF position or fluctuations of system altitude may be experienced for time periods up to 20 minutes.

6. UHF radios—ON.

CAUTION

UHF radio(s) may be turned ON, but do not transmit without cooling air on the aircraft (unless required by an emergency).

7. Lighting control panel—Checked.
Check operation of the interior light rheostats and set for desired intensity. Check operation of bright and dim switches and select desired intensity.

B 8. Malfunction and indicator lamps and stall warning system—Check.

- Pitot/probe heater switch—OFF/SEC.

WARNING

If pitot/probe heater switch has been in the HEAT position, residual heat in the probe may be sufficient to cause injury to ground personnel.

- Alpha probe slots—Full up. (Lowest angle-of-attack value) (GO)
- Malfunction and indicator lamps test button—Depress and check all malfunction and indicator lamps light, check for intermittent (landing gear) audible warning tone through headset.
- With malfunctions and indicator lamps test button depressed.
- Warning horn silence button operation.
- Malfunction and indicator lamps test button—Release.
- Stall warning system—Check. (After T.O. 1F-111-891)
- Alpha probe slots—Full down. (Highest angle-of-attack value) (GO)
- With malfunction and indicator lamps test button depressed, check stall warning lamp flashing, steady audible warning tone through headset, and rudder pedals shaker activated.

Note

When the lamps test button is depressed, the rudder may deflect due to AYC input and the yaw channel caution lamp may light. This is normal.

- Malfunction and indicator lamps test button—Release.
- Check malfunction and indicator lamps for abnormal indications.

Note

When the lamps test button is released, the yaw channel caution lamp may remain lighted, in which case, reset to put the lamp out.

9. Flap/slat and wing sweep handles correspond with surface position—Checked.

10. Oil quantity indicators—Checked.
Check that indicators show 16 quarts, place the oil quantity indicator test switch to OIL

QTY and check that indicators decrease to 5 quarts on the left indicator and 5.7 quarts on the right indicator and check that the oil low lamp lights. Release test switch and check that indicators return to original readings.

11. Oxygen quantity—Checked.
    Check that oxygen quantity is adequate for mission. Place oxygen quantity test switch to OXY QTY. Oxygen quantity indicator should decrease to zero. Note that the oxygen quantity caution lamp lights when indication is 2 liters. Release the test switch and note that the caution lamp goes out and that the quantity indication returns to original value.
12. Fire detect circuit—Checked.
    - Hold the agent discharge/fire detect test switch to FIRE DETECT TEST and check that the wheel well hot caution lamp and both engine fire warning lamps are lighted. Release the switch.
    - Position the fuselage overheat test switch to LOOP 1. The wheel well hot caution lamp shall not light.
    - Position the fuselage overheat test switch to LOOP 2. The wheel well hot caution lamp shall not light.

Note

The fire detection system ground test switches (on ground check panel) should be checked for normal position.

13. Ground check panel door—Closed.
14. AFRS synchronization indicator—Nulled.
15. Engine feed selector knob—FWD, then AFT.
    Check that the appropriate fuel pump low pressure indicator lamps (six) light and go out and that the L and R FUEL PRESS caution lamps are out.

*B 16. Fuel quantity and indicators—Check.
    If forward or aft tank pointers or totalizer fails to test or all tank quantities do not add up to the total fuel indication (± 1000) pounds, a malfunction is indicated.
    a. Fuel quantity—Checked.
       Check fuel quantity indications of all fuel tank gages against scheduled fuel load.
    b. Fuel quantity indicator test button—Depress and check:
       (1) Forward and aft tanks—2000 (±400) pounds.
       (2) Select tank—2000 (± 100) pounds.
       (3) Total fuel—2000 (± 1250) pounds.
    c. Check that forward and aft tank fuel quantity indicator pointers, totalizer, and select tank pointer move smoothly.

WARNING

If either forward or aft tank fuel quantity indicator pointers indicate a malfunction, do not fly the aircraft.

    d. Fuel distribution caution lamp—Lighted after 12 seconds.
    e. Fuel quantity indicator test button—Release.
    f. Fuel distribution caution lamp — Remains lighted for 10 to 15 seconds, then goes out.

17. Engine feed selector knob—AUTO.
    Select AUTO when the forward tank pointer is approximately 2000 pounds outside the bar index of the fuselage fuel quantity indicator.

Note

If fuel tank expansion space has been reduced due to fuel overfill or thermal expansion, some fuel venting may occur while the fuselage fuel quantity indicators are returning from the test indications if the engine feed selector knob is positioned to AUTO too soon. Fuel venting must cease prior to takeoff.

    a. Fuel distribution caution lamp—Lighted until distribution is within limits.

Note

If a malfunction is indicated in the fuel distribution system, position the engine feed selector knob to OFF to preclude possible fuel venting.

    b. Appropriate fuel pump low pressure indicator lamps—Light and go out.
    c. All indicators—Return to original indications.

18. Fuel transfer knob—AUTO.
    Hesitate at each position containing fuel and check that fuel low pressure indicator lamps blink and go out.

*N19. Stores control panel:
    a. Store present lamps—Checked.
       Check that store present lamps are lighted and displaying the proper store identification at each loaded station.
    b. Master switch—ON.

N 20. Computer program unit test/enable switch — ENABLE. (GO)

If electrical power is interrupted, either by turning the master power switch to OFF or removing ground power, the ENABLE relay will deenergize. To reenergize, ground power must be available, the master power switch ON, and the CPU Test/Enable switch momentarily actuated to ENABLE.

N 21. Stores control panel:

a. Selector mode knob—STA JETT.

b. Station select lamps—Out.

If any station select lamp is lighted, deselect stations.

c. Test button—Depressed.

While the stores control test button is depressed, check that station selected lamps are lighted for all loaded stations, all others out.

d. Selector mode knob—BOMB STEP S.

e. Test button—Depressed.

Check select lamps lighted for all weapon loaded stations, out for all others.

f. Selector mode knob—OFF.

g. Master switch—OFF.

BEFORE STARTING ENGINES.

Refer to figure 2-2, Danger Areas, for the extent of engine intake and exhaust hazard areas, and the engine turbine and starter turbine planes of rotation.

1. Auxiliary/parking brake handle—Pulled.

CAUTION

Do not perform this step if brakes are overheated.

2. Position lights—BRT and FLASH.
3. Weapons bay doors:

a. Lockpin—Removed. (GO)

b. Safety switch—NORMAL. (GO)

c. Safety panel cover—Closed. (GO)

4. Type start—Pneumatic/cartridge.

Confirm type of start with ground observer.

5. Ground crew report—Ready for engine start. (GO)

Fire guard posted, engine run area clear, chocks in place, both entrance ladders closed and latched with slot and indices lined up, and report ready for engine start.

WARNING

The slotted head on the entrance ladder release button must be aligned with indices on either side of the button to be assured that the ladder is latched in stowed position. Failure to do so could result in the ladder being blown into the engine inlet should it extend.

DEFINITIONS:

Hot Start—TIT exceed 710 degrees C.

If during start TIT increases at an abnormally rapid rate or approaches 655 degrees C and is still climbing, a hot start can be expected.

False or Hung Start—TIT increases but rpm will not increase to IDLE within 2 minutes.

Failure to Start—Engine does not light-up within 20 seconds after throttle is positioned to IDLE. If TIT does not rise or rpm does not increase above maximum starter output, a light-up has not been obtained.

Cartridge Start Misfire—Cartridge fails to ignite as indicated by lack of smoke at the starter exhaust port. There will be no engine rpm indication.

Cartridge Start Hangfire—Cartridge ignites as indicated by smoke at the starter exhaust port; however there will be little or no rpm indication.

If any of the above conditions occur return the throttle to OFF. Crew will record magnitude, duration, and other pertinent information to aid maintenance investigation of the malfunction.

The engine should be inspected for residual fuel before a second start is attempted. If no fuel is visible a second start may be attempted. The engine should be motored until TIT is below 100 degrees C before advancing the throttle to minimize the possibility of a hot start.

If visible fuel or vapors are found the engine must be cleared using the pneumatic starter as follows:

ENGINE CLEARING.

- Engine ground start switch—PNEU.
- Affected engine throttle—Lift.

Lift the throttle of the affected engine out of the OFF detent to motor the engine. This may be accomplished any time the engine rpm is below 20 percent.

CAUTION

To avoid a possible hot start do not advance the throttle.

- Affected engine throttle—Release.
  Release the throttle to OFF prior to the time limit specified for starter operation in Section V.

STARTING ENGINES.

Engine starts can be accomplished by using air pressure from a ground source or by a pyrotechnic cartridge. Only the left engine has cartridge starting capability. Either engine may be started by the use of external air when supplied by an adequate source; however, under some combinations of ambient temperature extremes and starter cart output variations, left engine starting capability may be marginal. For normal flight operations, it is recommended that the left engine be started first. This sequence will provide positive indications of starter dropout on both engines (right engine only after T.O. 1F-111(B)A-650). With either engine operating, the other engine may be started by pneumatic crossbleed; however this is necessary only during a cartridge start when no external air source is available, or when starting the right engine first because of marginal aircraft capability. Electrical power required for engine starting may be supplied by either the aircraft battery or by an external power source.

WARNING

- Do not attempt a pneumatic start or fly the aircraft with an unfired cartridge in the breech. Abnormal cartridge conditions of an explosive nature could be generated due to the combination of vibration and high temperatures that can exist in the engine nacelle.
- Do not initiate a cartridge start with any nacelle door open on the engine being started. To do so could result in possible overheating of adjacent structure and/or ignition of accumulated fuel and oil.

CAUTION

- If engine has had insufficient time to cool from a previous operation, do not attempt a restart until TIT is below 100 degrees C. Motoring of the engine will reduce the temperature.
- If hydraulic cooling ejector air is not present, do not advance throttle above IDLE.
- Insure that pivot pylon jettison ground safety lockpin and bomb rack ground safety pin streamer are not hanging within the danger area around the inlet ducts if pins are left in place during engine run.

1. Engine ground start switch—PNEU or CARTRIDGE. (As applicable)
2. Applicable engine throttle—Lift to start position.
   a. On a cartridge start advance the throttle to IDLE immediately.
   b. Oil pressure—Checked.

Note

- Oil pressure should be indicated within 10 seconds after first indication of rpm.
- During second engine start, check that the engine ground start switch moves to OFF prior to reaching 50 percent engine rpm. Cooling air will not be available if the switch is in any position other than OFF.
- Starter dropout is normally indicated by the hydraulic low pressure caution lamps going out at 38 to 41 percent on the left engine (except after T.O. 1F-111(B)A-650), and when the engine ground start switch moves to OFF for the right engine.

WARNING

In the event of aborted start during a cartridge start due to misfire, hangfire, or slow burning cartridge, the breech will not be opened until a time period of 5 minutes has elapsed after attempted start and no smoke can be observed emitting from the starter exhaust.

3. Engine throttle—IDLE.
   On a pneumatic start advance the throttle to IDLE after the engine rpm reaches 17 percent.

Note

TIT rise should occur within 20 seconds after throttle advance.

4. Engine instruments—Check.
   a. Fuel flow—1100 pph max.
   b. TIT indicator—710 degrees C max.
   c. Idle rpm—58 to 71 percent.
   d. Hydraulic pressure indicators — 2950-3250 psi, caution lamps out.
   e. Idle oil pressure—30 to 50 psi.
   f. Nozzle position—Open.
5. Engine overspeed caution lamp—Out.
6. Generator switch—START (pause), then release to RUN, check caution lamp out.

Note

If the generator caution lamp remains lighted, place the switch to OFF/RESET, hold to START (pause), then release to RUN.

7. Power flow indicator—TIE or NORM. (As applicable)
8. Hydraulic cooling ejector airflow—Check. (GO)
   After engine has been started, check that the engine ground start switch is in OFF so that the ground observer can check for the cooling ejector airflow.
9. Speed brake ground lock—Removed.
10. External power switch—OFF.
11. Start remaining engine—Repeat steps 1 thru 8.
12. External air conditioning, starter air and electrical power unit—Disconnected. (GO)

Note

Obtain ground clearance prior to advancing throttle to 80-85 percent for crossbleed starts.

13. Engine ground start switch—OFF.
14. Power flow indicator—NORM.
15. Emergency generator switch—TEST, ON, then AUTO.
    Place the emergency generator switch to TEST. The emergency generator indicator lamp will light after 1 second indicating that the emergency generator is operating within limits. The power flow indicator should display a crosshatch. Check operation of T/R units by noting that the angle-of-attack indexers and ODS reticle lamps are lighted. Place the emergency generator switch to ON, check power flow indicator displays NORM. Place the emergency generator switch to AUTO. Check that indicator lamp goes out and that the power flow indicator displays NORM.

Note

If battery power was utilized for engine start complete the "Power On" checks prior to proceeding to the next checklist.

AFTER ENGINE START.

"After Engine Start" checklists may be accomplished simultaneously.

PILOT.

1. TFR mode selector knobs (2)—STBY.
2. ILS and TACAN—On and set.
3. Radar altimeter—On, cleared. (GO)
   Set 80 feet.
4. Wing sweep—Set for takeoff.
5. Wing sweep handle lockout controls—ON.
6. Flight controls clear—Cleared. (GO)
7. Flight control and damper system—Check.

Note

During the following checks, the required flight control surface positions will be verified by the control surface position indicator or the ground observer.

a. Slats—Extended.
b. Takeoff trim—Set.
c. Damper switches (3)—OFF.
   Place the pitch and roll autopilot/damper and yaw damper switches to OFF and check that the pitch, roll and yaw damper caution lamps light.
d. Flight controls—Checked.
   - Move the control stick aft, then left wing down, right wing down: check for freedom of movement and verify that the control surfaces and surface position indicators correspond with control stick movement. Check that pitch and roll channel caution lamps do not light.
   - Move the control stick full forward, then rapidly full left through the detent to the forward left corner and hold firmly for one second. Verify that the right horizontal stabilizer indicates 12 to 18 degrees down while the stick is held in this extreme position.
   - Move the control stick rapidly full right through the detent to the forward right corner, firmly holding forward pressure. Verify that the left horizontal stabilizer indicates 12 to 18 degrees down while the stick is firmly held for one second in this extreme position, then release.
   - Rudder pedals—Check for more than 25 degrees of rudder in each direction.
e. Damper switches (3)—DAMPER.
f. Damper reset button—Momentarily depressed. (If necessary)
   Check that the pitch, roll and yaw damper caution lamps go out.
g. Trim—Checked. (Optional)
   Move auxiliary pitch trim switch to OFF, actuate stick trim button to NOSE DOWN and NOSE UP and check for no movement of stabilizers. Move auxiliary pitch trim

switch to NOSE DN, then NOSE UP; check control surfaces travel in response to switch positions. Move auxiliary pitch trim switch to STICK and check trim button NOSE DOWN, NOSE UP, RWD, LWD, and rudder trim left and right, check control surfaces give proper response to trim inputs. Leave control surfaces out of center for subsequent check of takeoff trim system.

8. Flaps/slats—Retracted.

Note

When the control system switch is in NORM and the slats are retracted, a small oscillation may occur in the horizontal stabilizers which will be transmitted through the airframe. This condition is normal and will disappear when the slats are extended.

9. Series trim—Check.
   - Takeoff trim—Set.
   - Trim nose up for one second.
   - Wait for the horizontal stabilizers to stop driving at more than 8 degrees trailing edge up before completing the next step.
10. Auto TF switch—AUTO TF.
    The control stick shall drive slightly forward, the TF fly up off caution lamp shall light and the reference not engaged lamp shall light. These checks are valid whether TF is operational or not.

CAUTION

Do not initiate the next step unless both stabilizers indicate more than 8 degrees trailing edge up. If necessary, place the auto TF switch to OFF and repeat "Series Trim" checks.

11. Surface motion test—Complete.
    - Stability augmentation test switch—SURFACE MOTION and hold until next step is completed.
    - Flight control master test button—Depress and hold for the following checks:
      - Rudder moves to right, then to the left.
      - Left horizontal stabilizer drives to near zero degrees.
      - Right horizontal stabilizer drives to approximately 10 degrees down.
      - Control system caution lamps do not light.
    - Flight control master test button—Release.
      - Rudder returns to neutral.
      - Both horizontal stabilizers may drift together in pitch.
12. Surface motion and light test—Complete.
    - Stability augmentation test switch—SURFACE MOTION & LIGHTS and hold until next step is completed.

CAUTION

Do not initiate the next step unless the horizontal stabilizers are more than 8 degrees trailing edge up. If necesary, place the auto TF switch to OFF and repeat "Series Trim" checks.

   - Flight control master test button—Depress and hold for the following checks:
     - Rudder initially drives right then returns to neutral.
     - Left horizontal stabilizer drives to near zero degrees.
     - Right horizontal stabilizer drives to approximately 10 degrees down.
     - Pitch, roll and yaw damper, channel, and pitch and roll gain changer caution lamps light (8).
   - Flight control master test button—Release.
     - Rudder initially drives left then returns to neutral.
     - Both horizontal stabilizers may drift together in pitch.

Note

If all the lamps do not light, cycle the control system switch to T.O. & LAND and return to NORM, then repeat the "Surface Motion and Light Test" checks. If all lamps still do not light, a malfunction is indicated and correction will be required before flight.

13. Damper reset button—Depress momentarily.
14. Auto TF switch—OFF.
15. All caution lamps—Out.
16. Flap/slat handle—Set for takeoff.
17. Spoiler monitor test—Checked.
    - Flight control master test button—Depress and hold.
    - Spoiler test switch—OUTBD and hold until:
      - Outboard spoilers momentarily extend, then retract.
      - Spoiler caution lamp lights.
    - Spoiler reset button—Depress.
      Check spoiler lamp out.

- Spoiler test switch—INBD and hold until:
  - Inboard spoilers momentarily extend, then retract.
  - Spoiler caution lamp lights.
- Flight control master test button—Release.
- Spoiler reset button—Depress.
  Check spoiler caution lamp out.

18. Ground roll spoilers/throttles—Check.
    - Ground roll spoiler switch—BRAKE.
      Check all spoilers extend.
    - Left throttle—Advance slightly, then IDLE.
      Check all spoilers retract, then extend.
    - Right throttle—Advance slightly, then IDLE.
      Check all spoilers retract, then extend.
    - Ground roll spoiler switch—OFF.
      Check all spoilers retract.
19. UHF, TACAN and ILS radios—Checked.
    Obtain altimeter setting and runway temperature from tower.
20. EPR/nozzle—Checked, set.
21. Autopilot—Checked.
    - Prior to T.O. 1F-111(B)A-593:
      - Pitch and roll autopilot/damper switches—AUTOPILOT. Control stick motion may occur.
      - Control stick steering—Checked.
        Move control stick and check that reference not engaged caution lamp lights. Lamp will go out when stick is returned to neutral.
      - Altitude hold and constant track switches—Engaged.
        Reference not engaged caution lamp lights.
      - Reference engage button—Depressed.
        Reference not engaged caution lamp goes out.
      - Move stick, then release.
        Reference not engaged caution lamp lights.
      - Reference engage button—Depressed.
        Reference not engaged caution lamp goes out.
      - Autopilot release lever—Depressed.
        Check that the roll and pitch autopilot/damper switches go to DAMPER and that the altitude/mach hold and constant track/heading nav selector switches go to OFF.
    - After T.O. 1F-111(B)A-593:
      - Pitch and roll autopilot/damper switches—AUTOPILOT. Control stick motion may occur.
      - Altitude hold and constant track switches—Engaged.
        The autopilot captures the reference altitude and track.
      - Autopilot release/PCSS lever—Depressed to second detent.
        Check that the roll and pitch autopilot/damper switches go to DAMPER and that the altitude/mach hold and constant track/heading nav selector switches go to OFF.
22. Radar altimeter—Checked.
    Depress and hold radar altimeter control knob, check for an indication of 95 (±12) feet prior to T.O. 1F-111-996 or 300 (±15) feet after T.O. 1F-111-996 and that radar altitude low lamp goes out. Select another channel and repeat test.
23. ISC—As desired.
24. Takeoff trim—Set, confirmed. (GO)
25. TFR operational check: (Prior to T.O. 1F-111-996)

WARNING

Do not transmit with the TFR if personnel or equipment are within the dangerous radar emission area. See figure 2-2.

Note

- If time prohibits pilot accomplishing this check on the ground, both crew members must accomplish inflight prior to TF operation.
- This check must be accomplished on the ground or above low altitude radar altimeter range (5000 feet absolute) to obtain proper light indications.
- When switching channels, or changing clearance plane settings, a momentary TF fail and fly-up maneuver may occur. Prior to T.O. 1F-111(B)A-593, the autopilot release lever can be held depressed to prevent the fly-up maneuver from occurring. After T.O. 1F-111(B)A-593, the autopilot release/pitch control stick steering lever can be held depressed to the first detent to prevent the fly-up maneuver from occurring.
- The flight vector caution lamp will be on until the INS is partially aligned.

a. Antenna cage pushbutton indicator lamp—Out.
b. TF, SIT and GM mode check—Complete.

Note

If, on the ground, the TF warning lamps stay lighted, check angle-of-attack indicator. If the reading is not in the range of plus 2 to plus 6 degrees, moving probe into this range will put the lamps out.

(1) TFR channel mode selector knobs—L TF, R SIT.
   (a) Channel fail caution lamp—Lighted.
      The Channel Fail Caution Lamp of the channel in TF should be ON, and the lamp of the channel in SIT should be OFF.
   (b) Reference or ATF not engaged caution lamp (as applicable)—Lighted.
   (c) TF fly-up off caution lamp—Lighted.
   (d) TF fail warning lamp—Lighted.

(2) ISC pitch steering mode switch—TF.
   The ISC must be in a mode other than ILS, AILA, or TKR RV.

(3) ADI/ODS pitch steering bars—Full up.

(4) Radar altimeter bypass switch—BYPASS.
   If check is performed on the ground the switch must be held in the bypass position.
   (a) Check TFR channel fail caution lamps—Out.
   (b) Check TF fail warning lamp—Out.
   (c) TF fly-up off caution lamp—Out.
   (d) Reference not engaged caution lamp—Lighted.
   (e) ADI/ODS pitch steering bars — Dive.

(5) Radar altimeter bypass switch—Release to NORMAL. (Ground check only)
   Any time the aircraft is below 5000 with radar altimeter operating, this switch will automatically release to normal.

(6) E scope—Checked.
   Adjust the contrast control until a thin vertical line along the right side of the E scan is discernible. Adjust the memory control knob so the sweep is repainted just prior to the fade point. Set the video knob to mid-point (adjust the optimum target display when at low altitude).

(7) Self-test pulse—Checked.
   Check for the presence of a test pulse.

(8) Zero command line—Check.
   (a) Ride control knob—Checked.
      Rotate thru each position. Check the zero command line position for proper movement and a smooth curve for the three ride settings.
   (b) Terrain clearance knob—Checked.
      Rotate thru each position. Check the zero command line position for proper movement and a smooth curve for all clearance settings.

(9) SIT and GM check—Checked.
   Rotate range selector knob from E to 5, checking for following indications: In 15 mile position, scope should show 15 mile range with three cursors evenly spaced. Check 10 and 5 for proper range and five evenly spaced range cursors. Switch to GM and check antenna tilt in 5 NM range. Return selector knob to E and check range cursors in GM 5, 10, and 15 as above.

c. TFR channel mode selector knobs—STBY.
d. Radar altimeter channel selector switch—Opposite channel.
e. Repeat TF, SIT, and GM mode check with TFR and radar altimeter channels reversed.

25A. TFR Operational Check: (After T.O. 1F-111-996)

WARNING

Do not transmit with the TFR if personnel or equipment are within the dangerous radar emission area. See figure 2-2.

Note

- If time prohibits pilot accomplishing this check on the ground, both crew members must accomplish "TFR Inflight Operational Check," Section IV prior to TF operation.
- This check must be accomplished on the ground to obtain proper lamp indications.
- When switching channels or changing clearance plane settings, a momentary TF fail may occur.
- The flight vector caution lamp will be lighted until the INS is partially aligned.

a. Antenna cage pushbutton indicator lamp — Out.
b. TF, SIT, and GM mode check—Complete.

Note

- If, on the ground, the TF warning lamps stay lighted, check angle-of-attack indicator. If the reading is not in the range of plus 2 to plus 6 degrees, moving probe into this range will put the lamps out.
- After T.O. 1F-111(B)A-651, the velocity caution lamp will be lighted during ground checks.

(1) Terrain clearance knob—Set 300 feet.

(2) Radar altimeter index pointer—Set 100 feet.

(3) TFR channel mode selector knobs — L TF, R SIT.

(a) Channel fail caution lamp—Lighted. The channel fail caution lamp of the channel in TF should be lighted, and the lamp of the channel in SIT should be out.

(b) Reference or ATF not engaged caution lamp (as applicable)—Lighted.

(c) TF fly-up off caution lamp—Lighted.

(d) TF fail warning lamp—Lighted.

(e) Radar altitude low warning lamp—Lighted.

(4) ISC pitch steering mode switch—TF.

(5) Radar altimeter control knob — Depress and hold.

(a) Radar altimeter—300 ($\pm$15) feet.

(b) Radar altitude low warning lamp—Out.

(c) TF failure warning lamp—Out.

(d) TFR channel fail caution lamps — Out.

(e) TF fly-up off caution lamp—Out.

(6) Radar altimeter bypass switch — BYPASS and hold.

(a) TF failure warning lamp—Lighted.

(b) Radar altitude low warning lamp—Lighted.

(c) TFR channel fail caution lamps — Lighted.
(d) TF fly-up off caution lamp—Out.
(e) Pitch steering bar and aural command will indicate a maximum climb command.

Note

The pitch steering bar and aural command may be indicating a climb command due to the presence of forward video. However, the induced fail condition of this test will provide a maximum climb indication for both the manual and aural command devices.

(7) Radar altimeter bypass switch—Release to NORMAL.
(a) TF failure warning lamp—Out.
(b) Radar altitude low warning lamp—Out.
(c) TFR channel fail caution lamps — Out.
(8) Terrain clearance knob—Set 400 feet.
(a) TF failure warning lamp—Lighted.
(b) Radar altitude low warning lamp—Lighted.
(c) TFR channel fail caution lamp — Lighted, for channel in TF mode.
(d) Pitch steering bar and aural command will indicate a maximum climb command.
(9) Radar altimeter control knob—Release.
(10) E scope—Checked.
Adjust the contrast control until a thin vertical line along the right side of the E scan is discernible. Adjust the memory control knob so the sweep is repainted just prior to the fade point. Set the video knob to midpoint (adjust for optimum target display when at low altitude).
(11) Self-test pulse—Checked.
Check for the presence of a test pulse.
(12) Zero command line—Check.
(a) Ride control knob—Checked.
Rotate thru each position. Check the zero command line position for proper movement and a smooth curve for the three ride settings.
(b) Terrain clearance knob—Checked.
Rotate thru each position. Check the zero command line position for proper movement and a smooth curve for all clearance settings.
(13) SIT and GM check—Checked.
Rotate the range selector knob from E to 5, checking for following indications: In 15 mile position, scope should show 15 mile range with three cursors evenly spaced. Check 10 and 5 for proper range and 5 evenly spaced range cursors. Switch to GM and check for antenna tilt in 5 NM range. Return range selector knob to E and check range and cursors in GM 5, 10, and 15 as above.

c. TFR channel mode selector knobs—STBY.
d. Radar altimeter channel selector switch — Opposite channel.
e. Repeat TF, SIT, and GM mode check with TFR and radar altimeter channels reversed.

26. Pitot heat—Checked (GO), then OFF/SEC.
Turn pitot/probe heater switch to HEAT and have ground crewman check probes for operation.

WARNING

Do not place pitot/probe heater switch to HEAT until ground crewman is ready to check the pitot probes, otherwise overheating may result with possible injury to ground crewman.

NAVIGATOR.

This checklist may be accomplished any time power and air conditioning are available.

1. Function select knob—GND ALIGN.
Check that the INS heat lamp lights immediately after entering ground align mode. The align lamp should light within 90 seconds after going to the ground align mode. Alignment is complete when the align lamp starts flashing.

Note

If only one computer and the INS are powered up simultaneously, the computer will halt.

2. RHAW power/audio control knob—Midpoint.
3. Radar function knob—STBY.
4. Data entry:
a. Data switch—ENTRY.

b. Data number—Enter 00.
c. Latitude/longitude—Enter to nearest .01.
d. *Magnetic variation—Enter to nearest .1.*

Note

Data cannot be entered into the computers *if the ALT CAL pushbutton was depressed* when the DCC was powered up.

5. INS reset button—Depress momentarily.
   If the align lamp is lighted, it will go out for one second after the INS reset button has been depressed.
6. Doppler radar pushbutton—Depressed, light on.
7. Astrocompass pushbutton—Depressed, light on.
8. *Astrocompass:*
   a. GHA of Aries—Enter to nearest .01.
      Depress (ENT) pushbutton at the time of selected GHA.
   b. Star altitude error/heading difference display—Checked.
      Check that the star altitude error/heading difference display is lighted and the astro compass is searching.

Note

Any momentary power interruption such as switching from external to aircraft power necessitates reentering GHA or Aries. If the star lost lamp is lighted when GHA of Aries is reentered, depress the star advance pushbutton after GHA of Aries reentry.

9. Horizontal situation display (HSD) data entry: (If applicable)
   a. Data switch—ENTRY.
   b. Address select switch—Data number. (201-250)
   c. Sequence number set wheels—Set to 00.
   d. Address select switch—LAT.
      Enter reference latitude.
   e. Address select switch—LONG.
      Enter reference longitude.
   f. Address select switch—ELEV/RMAP.
      Enter map radius (inches).
   g. Sequence number set wheels—Set to 01.
   h. Address select switch—LAT for Lambert Conformal or LONG for Mercator.
   i. Data entry pushbuttons—Enter central LAT or LONG.
10. RHAW system—Checked.
   a. Power/audio control knob—As desired.
   b. Sensitivity knob—As desired.
   c. Memory control knob—As desired.
      Normally fully counterclockwise.
   d. Brightness/Reticle intensity knob—As desired.
11. Attack radar—ON, tuned.
    Tune the radar for proper scope sweep, cursors, and range marks. The radar function knob will be placed to XMIT only during alert aircraft acceptance.

WARNING

Do not place radar function knob to transmit if personnel or equipment are within the *dangerous radar emission area.* See figure 2-2.

12. Mode selector knob—GND AUTO.
13. IFF—STBY and set.
14. IRRS function selector knob—STBY.
15. Sequence number verification — Accomplished as desired.
16. Weapon location and identification verification —Accomplished as desired.
17. Recording camera—Checked.
    Place the photo mode selector switch in AUTO and check for proper operation, then place the switch to OFF. (Use of narrow sector will decrease the time required to complete check.)

BEFORE TAXIING. (NAV READS)

B 1. Altimeters—Set.

WARNING

Do not push in on standby altimeter set knob when setting barometric pressure as disengagement of the gear train between the indicating pointers and the barometric scale may occur, resulting in erroneous altimeter readings. Observe that the pointers and barometric scale move simultaneously with set knob rotation.

B 2. Ejection handle and center beam safety pins—Remove, display to ground crew, and stow.
3. Weapons bay doors:
   a. Weapons bay doors—Clear. (GO)

b. Weapons bay door control switch—CLOSE.
c. Report weapon bay doors closed—Confirmed. (GO)

4. Air refueling receptacle — Confirmed closed. (GO)
5. Remove ground wire, interphone and chocks—Removing ground wire, interphone, and chocks, taxi on my signal. (GO)

N 6. *Nav mode select pushbuttons—Check 1 selected.*

N 7. Function select knob—NAV.

Placing the function select knob to NAV prior to obtaining a flashing align lamp can result in reduced INS accuracy.

8. Ready to taxi. (GO)

Pilot will signal with steady taxi light for ground observers to clear aircraft for taxiing. Flashing taxi light will notify crew chief to re-establish interphone communication.

Note

For normal training missions proceed with "Taxiing" checklist. If aircraft is to be placed on alert proceed with "Cocking" checklist.

TAXIING. (NAV READS)

Note

For "Turning Radius" during taxi operations, see figure 2-3.

TAXIING WITH WINGS AT 16-26 DEGREES.

1. ANTI - COLLISION LIGHT – ON NOTE

73-6 1A. Auxiliary/parking brake handle—In. ADDED

2. Nose wheel steering—Engaged.

Check that the nose wheel steering indicator lamp is on. Check engagement of nose wheel steering by slight movement of rudder pedals.

Note

Full nose wheel steering will not be available when slats are retracted and the flight control switch is in NORM. If full rudder authority is desired, place the rudder authority switch to FULL. Use of the T.O. & LAND position is not recommended. If turn radius is exceeded, range switch will automatically disengage controlled steering from rudder pedals and NWS/AR lamp will go out.

3. Hydraulic pressure—Checked.

Check for 2950 to 3250 psi indication.

4. Brakes—Checked.

Depress brake pedals and check for proper braking.

5. Flight instruments—Checked.

Check the flight instruments for proper operation during taxi.

TAXIING WITH WINGS AFT OF 26 DEGREES.

1. Flap/slat handle—UP.
2. Wing sweep handle lockout controls—Checked.

CAUTION

If fixed stores or multiple weapon racks are being carried, place the appropriate lockout control to ON to prevent sweeping stores into the fuselage and/or to prevent store-to-store contact.

3. Wing sweep handle—As required.

CAUTION

At light gross weights or with external stores, sweeping the wings full aft may establish an aft center of gravity condition, resulting in full nose strut extension and free castering of the nose wheel.

4. Nose strut extension—Checked. (GO)
5. Rudder authority switch—FULL. (Confirm)
6. Perform the steps under "Taxiing with Wings at 16-26 Degrees," this section.

BEFORE TAKEOFF. (NAV READS)

1. Wings, flaps, and slats—Set for takeoff.

Check for surface position indicator for selected wing, flap, and slat settings.

2. Ground roll spoiler switch—BRAKE.
3. Speed brake switch—IN.
4. Anti-skid switch—ON, caution lamp out.
5. Control system switch—NORM.
6. Rudder authority switch—AUTO.
7. Takeoff trim—Checked.

WARNING

A malfunction is indicated if the takeoff trim indicator lamp does not light immediately after takeoff trim button is depressed.

8. Engine/inlet and anti-icing switch—AUTO.
B 9. Fuel quantity and fuel distribution—Checked.
~~N 10. Anti-collision light—On.~~
3-6 ~~Turn anti-collision lights on and position lights to BRIGHT and STEADY.~~
N 11. Automatic sequencing—Initiated.
   • Sequence number set wheels—First destination.
   • Destination pushbutton—Depress.
   • Sequence number select pushbutton—Depress.
B 12. Flight instruments and radios—Set for takeoff.
   Command mach, airspeed, and altitude digital readouts should be set to meaningful values that are coordinated and understood by both crew members.

WARNING

Do not take off if the airspeed mach indicator reads greater than mach 0.42. An erroneous CADC output can result in improper mach trim functions of the engine fuel control unit causing a significant reduction in engine thrust (as much as 40 percent) on both engines, when the landing gear handle is placed to UP after takeoff. In the event of a sudden thrust reduction when the landing gear handle is placed to UP, with an accompanying abnormal mach indication, recover normal thrust by returning the landing gear handle to DN and land as soon as practicable.

N 13. Altitude calibration—Complete. (If desired)
B 14. Canopy hatches — Closed and latched, unlock warning lamp out.
B 15. Canopy latch handle lock tab—Flush.
   Snap the spring-loaded latch handle lock tab into the locked (flush) position and pull on the latch handle to check that it is locked.
B 16. Warning and caution lamps—Checked.
   Check that all warning lamps are out and that caution lamps are compatible with mission.
N 17. Radar transponder—As required.
B 18. Oxygen—As required.
B 19. Takeoff data—Checked.
20. Nuclear caution lamp—Out.
N 21. IFF master control knob—As required.
22. Pitot/probe heater switch—HEAT.
N 23. Radar function knob—As desired.
24. External stores jettison A and jettison B circuit breakers—Set.
25. Ground jettison switch—ARM.

WARNING

Prior to placing the ground jettison switch to ARM, insure that immediate area is clear of personnel, other aircraft and equipment.

B 26. Lower helmet visor—As practical.

Note

Whenever practical the flight crew shall lower helmet visors for protection against birds strikes which might cause windshield failure when flying at low levels.

TAKEOFF.

CAUTION

Failure of the engine nozzle to close when throttle is advanced to slightly above IDLE or nozzle failure in the open position will result in engine overspeed if throttle is advanced to a higher power setting.

1. Throttles—MIL.
2. Brakes—Release.
3. Throttles—MAX AB.
4. Engine instruments—Checked.

NORMAL TAKEOFF.

Normal takeoffs will be accomplished with wings positioned at 16 degrees and 25 degrees flaps. The recommended flap setting provides an optimum trade off between single engine rate of climb at takeoff speed and ground roll. It is recommended that maximum afterburner thrust be used for all normal takeoffs. Asymmetric afterburner operation presents no directional control problem and can easily be controlled with nose wheel steering or rudder as required. Takeoffs may be made from a standing or rolling start.

1. For standing start takeoffs, hold the brakes and advance throttles to MIL. When engines are stabilized at MIL, release brakes and smoothly advance throttle to MAX AB power. The engine instruments check should be made as soon as possible after reaching full maximum afterburner power.
2. For rolling start takeoffs, the takeoff check should be started as the aircraft becomes aligned with the runway. The engine instrument check should be made as soon as possible after reaching full maximum AB power.

Nose wheel steering should be used during the takeoff roll and should be disengaged at 80 knots (rudder becomes effective at 50 to 70 knots), since rudder displacement necessary for directional steering may be excessive for nose wheel steering. The aircraft instruments must be monitored closely to assure normal aircraft performance and operation. Particular attention must be paid to the nozzle position and EPR indicators to assure thrust requirements are at acceptable levels. Crosscheck airspeed indicators for proper operation. Decision (S1) speed is used as the decision point for either aborting or continuing the takeoff. The takeoff will be continued if aircraft operation is normal; otherwise the takeoff will be aborted. (Refer to T.O. 1F-111(B)A-1-1 for takeoff data computations.) At 15 knots below takeoff speed initiate back stick pressure to achieve a rotation rate that will result in a takeoff attitude at the recommended takeoff speed. Rotate the aircraft smoothly to takeoff attitude and avoid abrupt stick inputs (especially at light gross weights) that would result in rapid strut extension of the main landing gear at liftoff.

CAUTION

Abrupt stick inputs to rotate the aircraft will produce rapid rotation and liftoff, and may cause excessive loads to be applied to the main landing gear structure, possibly resulting in damage to the gear.

Adequate longitudinal control may be available to lift the nose wheel from the runway at lower speeds but it is recommended that this not be done since it will lengthen the takeoff distance slightly due to increased drag.

Note

- *Rotational characteristics of the aircraft will vary with gross weight, center-of-gravity position and external stores loading. Certain combinations (light gross weight and/or aft center-of-gravity location) will result in a fairly rapid rotation when aft stick force is applied. With a heavy aircraft and/or a forward center-of-gravity location, immediate rotation may not occur with aft stick movement and a much slower rate of rotation may be experienced. In some cases, takeoff attitude may not be achieved until takeoff speed is reached. Therefore, takeoff should not be aborted due to failure to rotate until takeoff speed is attained.*
- *If obstacle clearance is required, aircraft pitch attitude should be increased after takeoff to 15 degrees (not to exceed 13 degrees angle-of-attack). Do not retract flaps or slats until the obstacle has been cleared, pitch attitude reduced, and angle-of-attack is within recommended limits.*

Immediately after nose wheel lift off, a forward stick motion may be required to arrest the rotation of the aircraft, and the stick should be adjusted to maintain 10 degrees of pitch attitude for aircraft lift off. Landing gear retraction should be initiated when safely airborne. After lift off, maintain this attitude constant and as the aircraft accelerates retract the flaps/slats incrementally at a rate which will result in an angle-of-attack not to exceed 10 degrees. During heavy gross weight takeoff conditions (above 90,000 pounds) it will be necessary to maintain angle-of-attack between 8 and 10 degrees to avoid exceeding the flap limit speed.

WARNING

- Excessive angle-of-attack may result from retracting flaps.
- Maneuvering flight at angles-of-attack greater than 10 degrees should be avoided.

For typical takeoff, see figure 2-4. Refer to the Performance Appendix for takeoff data.

CAUTION

Failure to arrest rapid rotation rates generated at nose wheel lift off can result in aircraft tail bumper and/or engine tail feathers contacting the runway.

CROSSWIND TAKEOFF.

Under crosswind conditions, the aircraft tends to weather-vane into the wind. The weather-vaning tendency can be easily controlled with nose wheel steering until the rudder becomes effective. As forward speed increases, the weather-vaning tendency decreases. At speeds above approximately 50 knots rudder effectiveness will normally be sufficient to maintain directional control. Use of roll control will aid directional control and keep the wings level. Care should be exercised, however, to prevent inducing an excessive wing-low attitude at lift-off.

Note

Application of roll control may delay rotation due to a slight reduction in available pitch control.

After the aircraft leaves the ground, it should be crabbed into the wind, wings level, to maintain runway alignment. Refer to "Crosswind Takeoff and Landing Limits," Section V.

AFTER TAKEOFF/CLIMB. (NAV READS)

The ♦ items will be accomplished when climbing out of low level routes.

1. Landing gear handle—UP.
   When the aircraft is definitely airborne, retract the landing gear. Check that the landing gear position indicator lamps and the warning lamp in the landing gear handle go out. The landing gear and landing gear doors should be up and locked before reaching 295 KIAS.

WARNING

If it is necessary to depress the landing gear handle lock release button to move the handle to the UP position, the crew member should suspect a malfunction of the landing gear ground safety switch. In this event the spoilers will remain armed even with the landing gear retracted and the ground roll spoiler switch should be placed to OFF.

Note

The fuel tank pressurization caution lamp may light when the landing gear handle is moved to the UP position and remain lighted until the tanks are pressurized.

2. Flap/slat handle:
   a. Flaps—Retract flaps incrementally at a rate which will result in an angle-of-attack not to exceed 10 degrees.

WARNING

- Excessive angle-of-attack may result from retracting flaps too rapidly.
- If aircraft starts to roll off while retracting the flaps immediately return the flap/slat handle to original position and make no further attempts to operate the flaps. Sufficient lateral control may not be available to counter an asymmetrical flight condition. Refer to the appropriate procedure under "Landing With Flap And Slat Malfunctions," Section III.

   b. Slats—UP, and verified.
      Retract slats after verifying flaps are full up. Check that slat/aux flap indicator displays UP.

Note

- The rudder authority caution lamp will light momentarily while slats are in transit.
- Maintain 1 "g" until slats/flaps are fully retracted.

♦ 3. Wing sweep handle—As required.

CAUTION

If the slat/aux flap indicator displays crosshatch, do not sweep the wings without other verification that the flaps are up.

♦ 4. Auto TF switch—OFF.

♦ 5. Throttles—As required.
   For military power climb reduce throttles to MIL when climb speed is attained.

6. Ground jettison switch—OFF, guard down.

♦**B** 7. Engine instruments—Checked.

♦**B** 8. Fuel quantity indicators—Checked.
   Check the fuel quantity indicators for normal fuel usage.

♦**N** 9. TFR mode selector knobs (2)—STBY.

N 10. Nav modes—Selected.
   Select desired NAV modes.

♦**B** 11. Oxygen and cabin altitude—Checked.

N 12. Photo mode selector switch—AUTO.

♦**B** 13. Altimeters—Reset.

CLIMB.

The recommended climb speed, as shown in Appendix I, should be followed.

LEVEL OFF.

- **B** 1. Station check—Completed.
- 2. ISC—As desired.
- **N** 3. HF radio—SSB.
- **N** 4. IRRS function selector—As desired.
- **N** 5. ECM mode selectors (3)—REC. (If installed)
- **N** 6. RHAW power/audio control knob—As desired.
- 7. Radar altimeter—Set to 5000 feet.

CAUTION

Do not open the weapon bay doors in flight if a flight data recorder is installed (as indicated in the Form 781).

Note

Refer to crew duties, Section IV, for in flight procedures.

CRUISE.

After transfer of all external, weapon bay, and wing tank fuel, check fuselage fuel quantity indicators for normal distribution and usage. Forward and aft together should equal totalizer, (±1000) pounds.

WARNING

Failure of either forward or aft indicator pointers will cause improper forward and aft tank fuel distribution if engine feed is in AUTO. Do not remain in AUTO. Fuel distribution must be controlled manually to maintain cg within safe limits. A redundant fuel distribution monitoring system is included to provide aft center-of-gravity monitoring in any mode of engine feed. Refer to "Abnormal Fuel Distribution/Indication," Section III.

Refer to Appendix I for cruise operating data. Refer to Section I for fuel system operation.

AIR REFUELING.

Refer to T.O. 1-1C-1 for general air refueling procedures and to T.O. 1-1C-1-21 for specific air refueling procedures for this aircraft.

BEFORE DESCENT. (NAV READS)

Note

The navigator will monitor aircraft altitude, airspeed, angle-of-attack, configuration, and position during penetration, approach, and missed approach. Reference will be made to the applicable FLIP chart to ascertain that the aircraft is following the established pattern. The pilot will be notified of any significant deviation from the desired parameters, penetration, approach or missed approach pattern.

- **B** 1. Penetration and approach procedures—Checked.
  - a. Letdown plate—Reviewed.
  - b. Altitude calls—Reviewed.
    The navigator will announce the altitude when passing 15,000, 10,000, and 5,000 feet MSL. He will also notify the pilot 1,000 feet above initial level off and when approaching the DH/MDA. Both crew members will crosscheck altimeters during descent.
- 2. Radar altimeter—Set.
  Set the radar altimeter to the absolute altitude that corresponds to the DH/MDA.
- **B** 3. Fuel panel and quantity—Checked.
  Check fuselage fuel indicator totals against totalizer reading (±1000) pounds. If engine feed is in AUTO, verify normal distribution. If aft tank is empty (pump lamps lighted) switch to FWD.
- **N** 4. Landing data—Checked.
  Compute approach speed and stopping distance for initial landing/approach weight and configuration. If runway conditions remain the same, only approach speed need be computed for subsequent approaches and landing. If desired, compute wing sweep for landing from "Wing Sweep for Landing" chart.
- 5. Wing sweep handle and lockout controls—Set 26 degrees, ON.
  Check wing position indicator to assure wings moved to position selected.
- 6. Cabin air distribution control lever — As required.
- 7. Anti-skid switch—ON, caution lamp out.
- **B** 8. Oxygen—As required.
- 9. ISC/HSI course set knob—As required.
- 10. Ground roll spoiler switch—As required.
- **B** 11. Altimeters—Set.
- 12. Damper switches (3)—DAMPER.
- **N** 13. TFR mode selector knobs—STBY.
- **N** 14. RHAW system power/audio knob—OFF.

N 15. CMDS—Checked, SAFE and OFF.
N 16. ECM control knobs (3)—OFF.
N 17. IRRS function selector knob—OFF.

Note

Accomplish items 18 thru 21 if bombs are aboard the aircraft.

N 18. Bay door control circuit breaker—Out.
N 19. Stores control panel:
   a. Release enable switch—INHIBIT.
   b. Master switch—OFF.
   c. Delivery mode knob—OFF.
   d. Selector mode knob—OFF.
20. Nuclear consent switch—OFF, guard down. (As applicable)
21. Dangerous cargo radio call—Accomplished.

Note

Accomplish items **N**22 through **N**30 for all AILA/Monitored Approaches.

N 22. Function Select Knob—NAV.
N 23. Select sequence point pushbutton—DEST.
N 24. Fix mode selector knob—DEST.
N 25. Present position correction switch—IN.
N 26. Glide angle—Set to nearest 0.1 degree.
N 27. ODS mode selector knob—CMD. (If required)
N 28. Aiming reticle cage lever—Uncage. (If required)
N 29. Altitude calibration—Completed.
   Perform a low altitude calibration over the runway of intended landing if possible. If the cursors were repositioned to the end of the runway/offset and present position was not updated, when exiting the altitude calibration mode the cursors will jump the amount of present position error, and must be repositioned to the runway/offset.
N 30. Attack radar cursors—Positioned.
   Place the cursors as precisely as possible on the desired touchdown point or OAP. Prior to selecting AILA, on the ISC, if the cursors are repositioned to the end of the runway/offset and present position is not updated, the cursors will jump the amount of present position error when AILA is selected on the ISC, and must be repositioned to the runway/offset.

BEFORE LANDING. (NAV READS)

Note

See figure 2-5 for "Final Approach Airspeeds."

1. Speed brake switch—IN.
2. Wing Sweep—Set for landing and checked.
   Use one of the following procedures to determine wing sweep for landing.
   a. Elevator check—Complete.
      The elevator check may be performed at mach 0.70 or below and below 20,000 feet MSL in level flight with 26 degrees wing sweep and speed brake retracted. If the elevator trailing edge deflection is between 2 degrees trailing edge up and 1 degree trailing edge down, 26 degrees sweep should be used for landing. If the elevator trailing edge deflection is greater than 2 degrees trailing edge up, the wing should be swept forward until an elevator position of 0 degrees or 16 degrees wing sweep is reached. This wing sweep should be used for landing. For trailing edge deflections greater than 1 degree trailing edge down, refer to "Landing With Abnormal Fuel Distribution," Section III.
   b. Wing sweep from chart—Determined.
      Determine wing sweep for landing by referring to the "Wing Sweep for Landing" chart (if not previously determined).

Note

- The wings must be at 26 degrees or less to allow flap/slat extension.
- Prior to slat/flap extension, maintain an airspeed (250-300 KIAS) compatible with aircraft configuration and gross weight to insure that 10 degrees angle-of-attack is not exceeded during maneuvering flight conditions or during aircraft configuration changes.

3. Landing gear handle—DN.
   Extend the landing gear after airspeed is below 295 KIAS. Check that warning light in landing gear handle is out and landing gear position indicator lights are lighted.

WARNING

- After landing gear extension, selection of slats/flaps during decelerating flight should not be delayed, and extension of slats should be accomplished while gear is in the extend cycle. The command augmentation feature masks stall warning characteristics and rapid drag rise as airspeed decreases without slats and flaps extended. This may result in a rapid increase in angle-of-attack which the pilot may not be able to arrest before critical angle-of-attack limits are exceeded.

- Under landing conditions wherein airspeed may be above the gear warning horn setting, 160 (±12) KIAS, exercise caution to insure the landing gear is down and locked.

Note

The pitch and roll gain changer caution lamps will light when the gear is extended and will remain lighted until the slats are extended to approximately 70 percent.

4. Slats—Extend. (240 KIAS minimum)
   Extend the slats while the gear is in the extend cycle by positioning the flap/slat handle to the slat gate and make positive verification of slat position using the wing sweep flap/slat position indicator, visual check of slats and/or observation of the gain changer caution lamps. Since the gain changer caution lamps will remain lighted until the slats have extended to approximately 70 percent, this will provide an indication of slat position. When the gain changer caution lamps go out, extend the flaps. If the gain changer lamps remain lighted, and 70 percent flaps cannot be verified by other means, do not extend flaps; refer to Section III.

WARNING

- For normal operation, slats should be extended by a minimum airspeed of 240 KIAS. Do not roll or execute abrupt maneuvers with slats only extended.
- Do not extend flaps by normal or emergency method until approximately 70 percent slat extension has been verified. To do so could result in the flaps being locked at approximately 15 degrees with zero (or partial) slat extension. Flight in this configuration could result in stall or uncontrolled roll off. If the system locks, refer to "No (Or Partial) Slats And Partial Flaps Landing", Section III.

Note

- In the event slats/flaps do not extend with the wing sweep handle at the 26 degree detent, move the handle slightly forward of 26 degrees and reattempt extension.
- Airloads may prevent full slat extension at airspeeds approaching the slat limit speed; however, as airspeed is reduced resultant lowering of airloads will allow full slat extension.
- Maintain 1 "g" wings level until slats/flaps are extended to the desired position.

5. Flaps—Down and verified:
   a. Flaps—Down to 15 degrees.

WARNING

If aircraft starts to roll off after the slat/flap handle is placed to the 15 degree position, sufficient lateral control is available to counter an asymmetrical flight condition. Refer to "Flap/Slat Malfunction," Section III.

   b. Flaps—Full down.
6. ISC/HSI course set knob—As required.
7. Landing light—On.
8. Elevator position indicator (EPI)—Check.
   At 10 degrees angle-of-attack, check elevator position. If the elevator position is between 12 degrees trailing edge up (forward limit) and 4 degrees trailing edge up (aft limit) at 26 degrees wing sweep, or between 15 degrees trailing edge up and 6 degrees trailing edge up (12 and 4 respectively with Aux Flaps) at 16 degrees wing sweep, the aircraft is within the center-of-gravity limits. For wing sweeps between 26 and 16 degrees linearly interpolate using the elevator position values for no auxiliary flaps at 16 degrees wing sweep and values of 12 degrees (forward limit) to 4 degrees (aft limit) trailing edge up for 26 degrees wing sweep. If the elevator position is not in the above envelope, sweep the wing until it is. As the wing is swept forward from 26 degrees, the elevator required to trim will move in the down direction.

Note

The above elevator position range will provide safe operation for all landing wing sweeps and store loadings. For the aft limit for landing with a specific configuration, refer to Section V.

LANDING.

Note

See figure 2-6 for typical "Landing Pattern" and airspeeds.

Brakes should be used as required compatible with runway available. For Landing Data, refer to the Performance Appendix.

NORMAL LANDING.

Normal landings should be accomplished with wing sweep as required, full flaps and the pattern flown as illustrated on figure 2-6. For clean configuration, the initial approach should be entered at 300 KIAS. Enter the pattern as local policies dictate, using the throttles as necessary to maintain pattern airspeeds and altitudes. During the crosswind turn, do not exceed 60 degrees of bank maximum and adjust power to 80-85 percent. On downwind leg, wings level, extend the landing gear, slats, and flaps. Do not decelerate below 240 KIAS prior to full extension of slats. Flaps should be extended by a two-step procedure; first, extend flaps to 15 degrees, then to full down when below 220 KIAS. Although trim changes associated with gear and flap extensions are small, a noticeable decrease in angle-of-attack (approximately 0.25 degree per degree of flap extension) will be evidenced as slats and flaps are extended. Approximately 30 seconds (no wind condition), start base leg turn, with computed final approach speed plus 20 knots or 160 KIAS minimum, whichever is higher. Do not allow airspeed to drop below final approach speed plus 20 knots until rolled out on final approach.

WARNING

Throughout traffic pattern maneuvering, cross check the angle-of-attack indicator and indexers to assure 10 degrees angle-of-attack is not exceeded.

Complete the final turn with minimum clearance of 500 feet above field elevation. After rolling out on final approach and establishing the desired glide angle, adjust power as necessary to attain approach angle-of-attack indexer "on-speed" indication.

Note

Verify "on-speed" indexer operation by cross checking against angle-of-attack indicator and indicated airspeed.

Flying a 3.0 degree glide slope will produce a rate of descent of approximately 700 feet per minute. Use the angle-of-attack indexer to maintain an "on-speed" indication during final approach since this represents optimum approach angle-of-attack and airspeed and will automatically adjust airspeed for the gross weight of the aircraft.

Note

Turbulence, gusty winds, or other conditions may exist which may induce variations in angle-of-attack or airspeed or will cause excessive sink rates to develop on final approach. The pilot may decrease angle-of-attack to eight degrees or increase final approach speed 10 knots in such cases to improve aircraft handling characteristics. To avoid undesirable touchdown characteristics, this additional airspeed should be dissipated so that an "on-speed" indication exists prior to initiation of flare.

After the aircraft enters ground effect (approximately 30 to 50 feet above the ground), the aircraft will tend to rotate in the nose-down direction. At this point, the pitch attitude should be increased slightly (3-4 degrees) to reduce the descent rate to approximately one-half that used on final approach. Allow the aircraft to touch down in this attitude. This results in a "slow" indication at touchdown. After establishing touchdown attitude, reduce power slightly to lower aircraft to runway. Upon touchdown, smoothly retard throttles to IDLE, then lower nose wheel to runway. No attempt should be made to "grease" the aircraft on, as this delays compression of the struts and subsequent spoiler extension. A firm touchdown will allow spoiler extension when throttles are retarded to IDLE and result in a more comfortable and safer landing. When the spoilers extend, the aircraft will tend to fall through due to the center of rotation being shifted from the aircraft center of gravity to the main gear. Maintain directional control with rudder and differential braking until ready to turn off the runway or turn around on the runway. Normally nose wheel steering should not be engaged until speed has decreased to normal taxi speed. Normal ground roll distance is computed with brakes applied at 80 knots; however, brakes can be used throughout the landing roll. Refer to Appendix I for landing data.

WARNING

- Under no circumstances, during the landing phase, should the 14 degree angle-of-attack or stall warning activation limit be exceeded. Possible inadvertent stall and post-stall gyrations can result from exceeding this limit.
- Flying a steeper than normal final approach and/or not maintaining sufficient power through the flare for landing, may cause sink rates to exceed aircraft and landing gear design limits and increase the possibility of landing short of the runway.

CAUTION

Rapid or abrupt lateral or longitudinal stick motions can cause momentary increases in rate of sink and therefore should be avoided.

SHORT FIELD LANDING.

A short field landing is accomplished in the same manner as a normal landing except that particular attention must be given to precise airspeed, angle-of-attack, and glide slope control. Touchdown should be as close to the end of the runway as possible, with no landing flare. Observe sink rate limits. Refer to Section V. Reduce the power to IDLE at touchdown if this has not previously been done. Allow the aircraft to settle on the main landing gear and the ground roll spoilers to extend. After the spoilers have extended and the nose wheel is firmly on the runway, apply maximum anti-skid braking. Maximum braking performance is obtained in the three-point attitude with maximum weight on the main landing gear. Because of this, the stick should be eased aft when the brakes are applied, but caution should be exercised to insure that the nose wheel does not rise from the runway. The stick can be brought to the full aft position without unsticking the nose wheel at speeds below approximately 90 KIAS. Be prepared to lower the arresting hook and engage the runway barrier if the aircraft cannot be stopped prior to reaching the end of the runway. Maximum braking should be released, if practical, at approximately 25 knots to prevent the brakes from fusing and immobilizing the aircraft on the runway. At light gross weights, the anti-skid system cycling will be quite extreme and will continue throughout the ground roll until just before the aircraft is stopped. At heavier gross weights, little anti-skid cycling will be noted. If safety or operational considerations dictate that the ground roll must be the absolute minimum possible, touchdown can be made with full anti-skid braking applied.

HEAVY GROSS WEIGHT LANDING.

A heavy gross weight landing will be accomplished with a 16 degree wing sweep (if cg permits) in the same manner as a normal landing except that, maintaining an on-speed indication will result in higher approach and touchdown speeds. These higher speeds, due to heavier weights, result in increased braking requirements and stopping distances. Refer to Appendix I for landing data.

HYDROPLANING.

WARNING

If hydroplaning conditions exist, the landing roll will be increased by an indeterminate amount; therefore, be prepared for a departure end barrier engagement.

Dynamic hydroplaning is a condition where the tires of the aircraft are separated from the runway surface by a fluid. Under conditions of total dynamic hydroplaning, the hydrodynamic pressures between the tires and runway lift the tires off the runway to the extent that wheel rotation slows or actually stops. The major factors in determining when an aircraft will hydroplane are groundspeed, tire pressure, and depth of water on the surface. To a lesser degree, the surface texture, type of tire, and tire tread depth influence the total hydroplaning speed. Total dynamic hydroplaning in this aircraft with recommended tire pressure and .01 inch or more of water or slush on the runway can be expected at approximately 115 knots groundspeed (main landing gear) and 150 knots groundspeed (nose wheel) considering a takeoff gross weight of 86,000 to 90,000 pounds. These speeds will change as tire pressure is varied for takeoff gross weight. Partial dynamic hydroplaning occurs to varying degrees below these speeds. When an aircraft is subjected to hydroplaning to any degree, directional control becomes difficult. Under total dynamic hydroplaning conditions, nose wheel steering is ineffective and wheel braking is nonexistent. In addition to dynamic, two other types of hydroplaning can occur. Viscous hydroplaning can occur on a damp runway and at speeds less than those associated with dynamic hydroplaning, and is caused by a thin film of water mixed with rubber deposits and/or dust. Reverted rubber hydroplaning is caused by skid which boils the water on the runway, causing the rubber to revert to its natural latex state and seals the tire grooves, delaying water dispersal. Reverted rubber hydroplaning can occur at very low airspeeds. When possible hydroplaning conditions exist, pilots should be aware of the following:

1. Smooth tires tend to hydroplane with as little as .08 inch of water. New tires tend to release hydrodynamic pressures and will require in excess of .2 inches of water depth to hydroplane.
2. Takeoffs with crosswinds on water covered runways should be made with caution. An aborted takeoff on a wet runway initiated at or near hydroplaning speed will require considerably more runway than a dry runway abort and directional control of the airplane will be critical

until the speed has decreased below hydroplaning velocity.

3. In the absence of accurately measured runway water depths, pilots may use the following information to determine the possibility of hydroplaning when landing must be accomplished on a wet runway that does not have a porous surface or is not grooved:

   a. Rain reported as LIGHT—Dynamic hydroplaning unlikely, viscous and reverted rubber hydroplaning are possible.

   b. Rain reported as MODERATE—All types of hydroplaning are possible. Smooth tires will likely hydroplane; however, new tires are less likely to hydroplane.

   c. Rain reported as HEAVY—Hydroplaning will occur.

LANDING ON SLIPPERY RUNWAYS.

72-V

The technique for a slippery runway landing is essentially the same as that for a short field landing. During the high speed portion of the landing roll, particularly under wet or icy conditions, little braking capability will be available. This is because of the low coefficient of friction available due to hydroplaning or a very low RCR. Maximum aerodynamic braking should be used throughout the landing roll to aid in decelerating the aircraft. To avoid inhibiting wheel spin-up, and to improve wet runway wheel cornering capability, insure that the aircraft is firmly on the runway and positively under control prior to applying brakes. On wet runways during the high speed portion of the roll, little deceleration will be felt due to rapid anti-skid cycling. As speed decreases, braking potential on a wet runway will increase and brakes should be applied as required to stop the aircraft. On an icy runway, the coefficient of friction will remain fairly constant throughout the landing roll and brakes should be applied as required. Aerodynamic control, differential braking and nose wheel steering may be used to maintain directional control. Nose wheel steering should not be required until areodynamic control becomes ineffective. If planned stopping distance indicates that a stop on the runway is doubtful, divert or make either an approach end or departure end barrier engagement, depending on the severity of the situation. Refer to Appendix I for ground roll distance for various runway conditions.

CROSSWIND LANDING (DRY RUNWAY).

72-2

When crosswind conditions are encountered, a crab technique on final approach should be used to compensate for drift. Under visual conditions a wing-low drift correction technique may be used, however, airspeed and glidepath control becomes more difficult. Additionally, when the aircraft sideslips to the right, airflow to the angle of attack sensor begins to be blanked by the aircraft nose at a sideslip angle of approximately 10 degrees. As the sideslip angle is increased beyond this point, the angle of attack sensor indicates increasingly lower values of angle of attack. Therefore, it is recommended that steady-state rudder inputs be kept below seven degrees as inputs of a larger magnitude may result in erroneous angle of attack indications. Sideslip to the left will not affect the angle of attack sensor; therefore, the aircraft may sideslip to the left to the limits presented in the flight manual. During the transition to touchdown (approximately 75 feet above the ground), the drift correction technique should shift gradually from a crab to a wing low crabbed correction at touchdown. The pilot should attempt to touch down with no drift and the longitudinal axis of the aircraft aligned with the runway, which will minimize sideloads on the landing gear. However, if the crosswind component is excessive, it will be necessary to land in a combination wing-low crabbed attitude, not to exceed 10 degrees yaw or crab angle at touchdown.

CAUTION

External tanks at stations 2 or 7 will contact the ground at a bank angle of 15 degrees.

During touchdown from a wing-low crabbed approach, the pilot may experience the sensation of bouncing from gear to gear which may be aggravated by use of roll control in attempting to keep the wings level. The probability of this occurring will be reduced if a firm touchdown at the recommended angle of attack is accomplished. If this condition is encountered, minimize use of roll control until the aircraft has settled through the struts and is firmly on the ground. After touchdown, the pilot should use rudder, roll control and differential braking as required to maintain directional control. Roll control effectiveness may be increased significantly by "cracking" a throttle, thereby retracting the spoiler brakes and allowing the spoilers to function as an aid to roll control. When the desired directional control change is achieved, return the throttle to idle to extend the spoiler brakes. If nosewheel steering is required, it should be initiated with the rudder pedals at or near neutral, since the nosewheel will rapidly assume a position relative to the rudder pedal position at engagement. Unless required for directional control, nosewheel steering should not be engaged until the aircraft has slowed to taxi speed and just prior to turning off the runway. When landing with slats/flaps up, refer to "Crosswind Takeoff And Landing Limits", Section V, for recommended touchdown technique and limits. When landing with augmentation off, refer to "Dampers Off Landing", Section III.

CROSSWIND LANDING (SLIPPERY RUNWAY).

)2-2

The problem of maintaining directional control on a slippery runway becomes more difficult as the effective crosswind is increased. Consequently, aircraft flight path alignment with the runway must be established during the approach to prevent drift at touchdown. Restricted visibility, poor ground references, and crab angle will further complicate the task of establishing alignment during the approach. Pilots should be aware that excessive maneuvering during the final phase of the approach may induce misalignment and/or drift and may make it impossible for the pilot to determine actual aircraft track.

WARNING

> Proper runway alignment for approaches and landings under low RCR conditions is extremely critical. Avoid excessive maneuvering on final approach under these conditions. Aircraft drift or flight path misalignment at touchdown increases susceptibility to skidding or hydroplaning, which may cause loss of directional control during landing roll. If aircraft drift is not corrected prior to touchdown, execute a missed approach.

Plan the landing pattern to be established on final approach using a crab technique to correct for drift. This will insure that the aircraft is tracking straight down the center line of the runway. Establish a normal rate of descent and plan to touch-down approximately 500 feet down the runway or at the glide slope/runway interception point (if applicable). Make a firm touchdown with no flare (observe sink rate limitations, Section V) while maintaining the drift correction. Touching down in a crab will help insure that the runway center line track is maintained. Due to visibility restrictions that may occur with a crabbed approach, a combination crabbed/wing-low technique may be necessary during the transition to touchdown. Immediately after touchdown, retard throttles to idle and lower the nose to the runway. Aerodynamic (rudder and roll) control, differential braking, and nose-wheel steering may be used to maintain directional control; however, nose-wheel steering should not be required until aerodynamic control becomes ineffective. Roll control effectiveness will be increased significantly by "cracking" a throttle, thereby retracting the spoiler brakes and allowing the spoilers to function as an aid to roll control. When the desired directional control change is achieved, return the throttle to idle to extend the spoiler brakes. If nose-wheel steering is engaged, inputs should be kept small as steering effectiveness diminishes rapidly with nose-wheel deflections of more than 10°.

Note

- If directional control cannot be established or maintained, immediately advance power as required to accomplish a go-around.
- After directional control is well established, use the technique described under landing on Slippery Runways, this section, to stop the airplane.

LANDING WITH PARTIAL FLAPS.

A partial flap landing is accomplished in the same manner as a normal landing except that, maintaining an "on-speed" indication will result in higher approach and touchdown speeds (approximately 1.7 knots increase in airspeed for each degree of flap less than full flaps with 16 to 26 degree wing sweep). Due to the higher approach and touchdown speeds, braking requirements as well as stopping distances will be increased.

LANDING WITH SLATS EXTENDED AND FLAPS RETRACTED OR WITH SLATS AND FLAPS RETRACTED.

Approaches with wings and flaps in other than normal landing configuration will necessitate a long shallow, straight-in approach. If it is necessary to land the aircraft in this configuration, refer to "No Flap Landing," Section III.

TOUCH AND GO LANDINGS.

Touch and go landings should be accomplished using the same technique as presented in the "Normal Landing" and "Normal Takeoff" procedures this section. After touchdown power should be reduced to IDLE to allow the aircraft to decelerate and the nose wheel lowered to the runway. Directional control should be maintained with the rudder pedals. After the nose wheel has been lowered to the runway, smoothly advance the throttles to MIL or AB power as required. Check engine instruments for normal indications and caution lamps for malfunction warning. Lift nose wheel off runway 10 knots below previous approach speed. Accomplish "Transition Checklist" prior to each "Touch and Go Landing." If the aircraft reenters normal visual traffic, retract flaps/slats and accelerate to 300 KIAS (250-300 KIAS for rectangular traffic pattern). For subsequent radar patterns, traffic density will dictate airspeed and flap/slat position.

TRANSITION CHECKLIST.

When making a series of approaches and/or landings, this checklist will be used in lieu of "Before Landing" checklist provided the "Before Landing" checklist was accomplished prior to the initial approach and/or landing.

On The Go:

1. Speed brake switch—IN.
2. Power—Advanced.

B 3. Engine instruments—Checked.

4. Landing gear handle—UP.
5. Flap/slat handle:
   a. Flaps—Retract flaps incrementally at a rate which will result in an angle-of-attack not to exceed 10 degrees.

WARNING

- Excessive angle-of-attack may result from retracting flaps too rapidly.
- If aircraft starts to roll off while retracting the flaps immediately return the flap/slat handle to original position and make no further attempts to operate the flaps. Sufficient lateral control may not be available to counter an asymmetrical flight condition. Refer to "Landing With Flap and Slat Malfunctions," Section III.
- If any malfunction is indicated or suspected during flap retraction it is recommended, flight conditions permitting, that the flaps not be further actuated until over an approved drop or unpopulated area. A landing utilizing normal landing procedures can be accomplished if the slats/flaps return to original position. If they do not, refer to "Landing With Flap and Slat Malfunctions," Section III.

   b. Slats—UP, and verified.
      Retract slats after verifying flaps are full up. Check that slat/aux flap indicator displays UP.

Note

- The rudder authority caution lamp will light momentarily while slats are in transit.
- Maintain 1 "g" wings level until slats/flaps are fully retracted.

On Downwind (Nav Reads):

6. Wing sweep handle—Set for landing.
7. Hydraulic pressure—Checked.
   Check for 2950 to 3250 psi indication.

B 8. Fuel quantity and feed—Checked.

N 9. Landing data—Checked.

10. Landing gear handle—DN.
    Extend the landing gear after airspeed is below 295 KIAS. Check that warning light in landing gear handle is out and landing gear position indicator lights are lighted.

WARNING

- After landing gear extension, selection of slats/flaps during decelerating flight should not be delayed, and extension of slats should be accomplished while gear is in the extend cycle. The command augmentation feature masks stall warning characteristics and rapid drag rise as airspeed decreases without slats and flaps extended. This may result in a rapid increase in angle-of-attack which the pilot may not be able to arrest before critical angle-of-attack limits are exceeded.
- Under landing conditions wherein airspeed may be above the gear warning horn setting, 160 ($\pm$12) KIAS, exercise caution to insure the landing gear is down and locked.

Note

The pitch and roll gain changer caution lamps will light when the gear is extended and will remain lighted until the slats are extended to approximately 70 percent.

11. Slats—Extend. (240 KIAS minimum)
    Extend the slats while the gear is in the extend cycle by positioning the flap/slat handle to the slat gate and make positive verification of slat position indicator, visual check of slats and/or observation of the gain changer caution lamps. Since the gain changer caution lamps will remain lighted until the slats have extended to approximately 70 percent, this will provide an indication of slat position. When the gain changer caution lamps go out, extend the flaps. If the gain changer lamps remain lighted, return the flap/slat handle to up and make a "No Flap Landing," refer to Section III.

WARNING

- For normal operation slats should be extended by a minimum airspeed of 240 KIAS. Do not roll or execute abrupt maneuvers with slats only extended.

- Do not extend flaps by normal or emergency method until approximately 70 percent slat extension has been verified. To do so could result in the flaps being locked at approximately 15 degrees with zero (or partial) slat extension. Flight in this configuration could result in stall or uncontrolled roll off. If the system locks, refer to "No (Or Partial) Slats And Partial Flaps Landing," Section III.

Note

- In the event slats/flaps do not extend with the wing sweep handle at the 26 degree detent, move the handle slightly forward of 26 degrees and reattempt extension.
- Airloads may prevent full slat extension at airspeeds approaching the slat limit speed; however, as airspeed is reduced resultant lowering of airloads will allow full slat extension.
- Maintain 1 "g" wings level until slats/flaps are extended to the desired position.

12. Flaps—Down and verified.
    a. Flaps—Down to 15 degrees.

WARNING

If aircraft starts to roll off after the slat/flap handle is placed to the 15 degree position, sufficient lateral control is available to counter an asymmetrical flight condition. Refer to "Landing With Flap/Slat Malfunction," Section III.

    b. Flaps—Full down.
13. ISC/HSI course set knob—As required.
14. Landing lights—On.
15. Elevator position indicator (EPI)—Check.

    At 10 degrees angle-of-attack, check elevator position. If the elevator position is between 12 degrees trailing edge up (forward limit) and 4 degrees trailing edge up (aft limit) at 26 degrees wing sweep, or between 15 degrees trailing edge up and 6 degrees trailing edge up (12 and 4 respectively with auxiliary flaps) at 16 degrees wing sweep, the aircraft is within the center-of-gravity limits. For wing sweeps between 26 and 16 degrees, linearly interpolate using the elevator position values for no auxiliary flaps at 16 degrees wing sweep and values of 12 degrees (forward limit) to 4 degrees (aft limit) trailing edge up for 26 degrees wing sweep. If the elevator position is not in the above envelope, sweep the wing until it is. As the wing is swept forward from 26 degrees, the elevator required to trim will move in the down direction.

Note

The above elevator position range will provide safe operation for all landing wing sweeps and store loadings. For the aft limit for landing with a specific configuration, refer to *Section* V.

SIMULATED SINGLE ENGINE LANDING.

Simulated single engine landing should be flown with one engine at idle rpm, following the "Single Engine Go-Around" procedure, Section III.

GO-AROUND.

The decision to go around should be made as early as possible. When the decision to go around is made, smoothly advance the throttles and continue the approach because a touchdown may be necessary. As the aircraft accelerates, rotate the nose to a climbing attitude and when the altimeter and vertical velocity show a definite rate-of-climb proceed with the normal after takeoff checklist. Fly clear of the runway as soon as practicable. In the accomplishment of a go-around from the approach condition at light gross weight, application of MAX AB on both engines will result in a significant nose-up pitching moment. The forward stick movement to counter the induced nose-up moment, plus the normal forward stick required to maintain level flight as the aircraft accelerates, results in a large forward stick deflection. Forward stick trim authority may not be sufficient to correct this nose-up tendency, and forward control stick application may be required. However, adequate longitudinal control is available to maintain level flight.

CLOSED PATTERNS.

Closed traffic patterns are normally flown in clean configuration at 250-300 knots by initiating a smooth climbing turn to a point abeam intended touchdown, where aircraft configuration for landing is established.

TAXI-BACK LANDINGS.

When accomplishing a taxi-back landing, do not turn off the runway short of the end if braking requirements cause the normal brake energy limits in Section V (18 million foot pounds) to be exceeded. The full runway length should be used if excessive braking would be required to turn off sooner. This will reduce

heat build-up in the brakes and insure maximum braking capability for subsequent operations.

CAUTION

Have ground crew check brake temperature prior to setting auxiliary parking brake. If the temperature is acceptable to the bare hand, the auxiliary parking brake may be set. The "Taxi-Back Checklist" will be accomplished after clearing the runway. When a seat change is required, the change sequence is immaterial. During the seat change, ground interphone communications will be established. When both stations are being changed, a responsible individual will occupy the first vacated seat until the other seat change is completed. Extreme caution must be exercised throughout the maneuver. Engines should remain at IDLE. Personnel will secure loose equipment to prevent its ingestion into an engine. If the forward equipment hot lamp lights insure that the area in front of either engine is clear, then advance engine rpm to 80 percent. When the lamp goes out, retard the throttle to IDLE and complete the seat change. If the lamp does not go out, refer to "Caution Lamp Analysis", Section III.

Note

Items preceded by an asterisk are accomplished only if a seat change is required.

1. Nose wheel steering—Engaged.
N 2. Radar function knob—STBY.
N 3. Nav mode select pushbutton—TAS/D/A deselected.
4. Radar altimeter—OFF.
5. Landing and taxi lights switch—OFF.
6. Ground roll spoiler switch—OFF.
7. Pitot/probe heater—OFF/SEC.
N 8. IFF master control knob—STBY.
* **B** 9. Ejection handle and center beam safety pins—Installed.
* 10. Ground communications—Established.
* 11. Seat changed—Accomplished.
* **B** 12. Ejection handle and center beam safety pins—Removed.
* 13. Remove interphone and chocks—Chocks removed, disconnecting interphone (GO).
14. Wings, flaps, and slats—Set for takeoff.
    Check the surface position indicator for selected wing, flaps, and slat settings.
15. Speedbrake—IN.
16. Ground roll spoiler switch—BRAKE.
17. Radar altimeter—As required.
18. Take off trim—Set.
B 19. Flight instruments and radios—Set for takeoff.
B 20. Canopies—Closed and latched, warning lamp out.
B 21. Canopy latch handle lock tabs—Flush.
B 22. Warning and caution lamps—Checked.
B 23. Oxygen—As required.
B 24. Takeoff data—Checked.
    Determine the nozzle/EPR values used for takeoff. Rotation speed will be the final approach speed used for the previous approach.
N 25. Attack radar—As required.
N 26. IFF master control knob—As required.
N 27. Nav mode select pushbutton—As required.
28. Pitot/probe heater—Heat.
B 29. Lower helmet visor—As practical.

Note

Proceed with "Takeoff Checklist." If aircraft is to remain in closed traffic accomplish "Transition Checklist" after takeoff.

AFTER LANDING. (NAV READS)

CAUTION

- To prevent damage to the canopy, do not open canopy with cabin pressurized. Prior to opening canopy, check that cabin pressure altimeter agrees with field elevation. If cabin is pressurized, place the pressurization selector switch to DUMP prior to opening canopy. (Equipment cooling is not affected with this switch in DUMP.)
- At light gross weights or with external stores, sweeping the wings full aft may establish an aft center-of-gravity condition resulting in full nose strut extension and free castering of the nose wheel.

1. Nose wheel steering—Engaged.
2. Pitot/probe heater—OFF/SEC.
N 3. Radar function knob—STBY.
N 4. Nav mode select pushbuttons — TAS/D/A deselected.
N 5. HF radio—OFF.
6. Radar altimeter—OFF.
7. Landing and taxi light switch—OFF.
8. Ground roll spoiler switch—OFF.

9. Flap/slat handle—As required. (Normally extended)
   If slats are retracted, place rudder authority switch to FULL to insure full nose wheel steering.

N 10. IFF master control knob—OFF.

N 11. Weapons bay door control switch—OPEN. (As required)

~~N 12. Anti-collision lights switch—OFF.~~

73.6 **B** 13. Crew module ejection handle and center beam safety pins—Installed.

Note

- The ejection handle safety pins provided must be inserted center console outboard to preclude interference of the pins with seat adjustment.
- Destruct panel lockout pins installed if previously removed.

14. Engine feed selector knob—OFF.

ENGINE SHUTDOWN. (NAV READS)

73.6 1. Wheels—Chocked. (GO)

1A Anti Collision Lt - OFF

2. Wing sweep handle—As required.
3. Flap/slat handle—As required.

N 4. Function select knob—OFF.

5. Aerial refuel switch—OPEN. (If used)
   The engine feed selector knob must be in AUTO or BOTH before the air refueling receptacle will open.
6. Applicable throttle—OFF.

Note

The flight control system computers operate on 115 volt ac power from the essential ac bus. The essential ac bus is, in-turn, normally fed by the left generator. An interruption of power to the essential ac bus, such as loss or shutting down of the left generator or switching from left generator to external power will cause a mild shifting of the flight controls. This may also be accompanied by stick movement. Usually this will be felt as a mild air frame disturbance and should not be cause for concern.

7. Dampers—OFF.
8. Hydraulic pressure—Checked.
   Check for 2950 to 3250 psi indication.
9. Power flow indicator—Check TIE.
10. Remaining throttle—OFF

Note

Do not move the control stick after shutting down the last engine. To do so will invalidate the following horizontal tail droop check.

11. Horizontal tail droop check—Completed.

WARNING

If both horizontal stabilizers do not droop (symmetrically or asymmetrically) within 60 seconds, a malfunctioning horizontal stabilizer servo valve is indicated, which will require corrective action prior to next flight.

12. Emergency generator—Checked.
    The emergency generator-indicator lamp will light momentarily as the last engine driven generator disconnects from the ac buses. The lamp will go out when hydraulic pressure driving the emergency generator is depleted.

B 13. All switches and controls—Off, normal or safe.

WARNING

If the oxygen lever is left on and the regulator is set to EMER, liquid oxygen may flow through the regulator, creating a potentially hazardous situation.

POSTFLIGHT.

1. External stores jettison A, jettison B and nuclear master circuit breakers—Out. (Bombs aboard)
2. Ground safety locks and safety pins—Installed. (GO)
   Pilot must insure maintenance personnel have installed all ground safety locks and pins prior to departing. If qualified personnel are not available, locks and pins will be installed by aircrew.

Note

Ground safing procedures will be performed by aircrew if qualified MMS personnel are not available. (See ground safing procedures, this section.)

3. Ground safing procedures—Performed. (If applicable)
4. Bomb discrepancies—Reported.
5. Applicable forms—Completed.

This is the last page of Section II.

SECTION III

EMERGENCY PROCEDURES

TABLE OF CONTENTS.

This section contains procedures to be followed in the event of an emergency condition. These procedures will insure maximum safety for the crew and/or aircraft until a safe landing or other appropriate action is accomplished. Although the procedures contained herein are considered the best available, the pilot must exercise sound judgment when confronted with an emergency. The CRITICAL items (ALL CAPITAL BOLD FACE LETTERS) contained in the various emergency procedures are those steps which must be performed immediately without reference to written checklists. These critical steps shall be committed to memory. All other steps, wherein there is time available to consult a checklist, are considered NON-CRITICAL. The nature and severity of the encountered emergency will dictate the necessity for complying with all or part of the steps in a particular procedure. It is essential, therefore, that aircrews determine the correct course of action by use of sound judgment. As soon as possible, the pilot (aircraft commander) should notify the other crew member and flight leader of any existing emergency and of the intended action. When an emergency occurs, three basic rules are established which apply to airborne emergencies. They should be thoroughly understood by all aircrews.

1. Maintain aircraft control.
2. Analyze the situation and take proper action.
3. Land as the situation dictates.

Note

It is impossible to establish a pre-determined set of instructions that would provide a ready-made decision applicable to all situations. The emergency conditions combined with the pilot's analysis of the conditions of the aircraft, type of emergency and his proficiency are of prime importance in determining the urgency to land. The following provides general guidance.

Land As Soon As Possible:

An emergency will be declared. A landing should be accomplished at the nearest suitable airfield considering the severity of the emergency, weather conditions, field facilities, aircraft gross weight and command guidance.

Land As Soon As Practicable:

The mission should be terminated. Landing will be accomplished at a suitable alternate or the planned destination at the discretion of the pilot.

Note

- During any inflight emergency when structural damage is known or suspected that may adversely affect aircraft handling characteristics, a controllability check should be performed at a safe altitude. This check should be performed in the anticipated landing configuration. If adequate control response is available, and if it is practicable, maintain this configuration for landing.
- All odors not identifiable by the flight crew shall be considered toxic. Immediately go on 100% oxygen. Properly vent the aircraft and land as soon as practicable. Do not take off when unidentified odors are detected.
- The canopy hatches should remain closed during all emergencies that could result in a crash or fire such as crash landings, aborted takeoffs, and barrier engagements. The protection the canopies afford the crew during these emergencies far outweighs the isolated risk of entrapment due to a canopy malfunction or overturn.

GROUND OPERATION EMERGENCIES

ENGINE FIRE.

1. **THROTTLE(S)—OFF.**
2. Motor engine.

   Affected engine throttle—Lift for 20 seconds. (If air is available)

Note

When the engine ground start switch is out of the OFF position, nose wheel steering will be operative only while the nose wheel steering/air refuel button is depressed.

If Fire Persists:

3. Fire pushbutton for affected engine—Depress.
4. Agent discharge—Actuate.

WARNING

The fire extinguishing agent is available for one actuation only. Depressing the engine fire pushbutton the second time will reopen the fuel shutoff valve and disarm the fire extinguisher agent discharge valve.

5. Abandon the aircraft.

EMERGENCY AIRCRAFT BRAKING.

In the event normal pedal braking is not available, several methods may be used to obtain braking and/or control aircraft speed to prevent damage to the aircraft and other equipment. The following are suggested solutions. However, the sequence will be dictated by the situation.

1. Anti-skid—OFF.
2. Thrust reduced.
3. Barrier engagement.
4. Auxiliary/parking brake handle—Pull.

ABANDONING THE AIRCRAFT ON THE GROUND.

In an emergency requiring ground abandonment, the primary concern should be to leave the immediate area of the aircraft as soon as possible. Salvaging emergency and survival equipment should not be considered. To abandon the aircraft, disconnect personal leads and harness, open canopy hatches and exit over the side of the cockpit.

1. Throttles—OFF.
2. Fire pushbuttons—Depress.
3. Battery switch—OFF.

EMERGENCY ENTRANCE.

Emergency entrances are shown in figure 3-6.

TAKEOFF EMERGENCIES

ABORT/BARRIER ENGAGEMENT.

1. **THROTTLES—IDLE. (OFF FOR FIRE)**
2. **EXTERNAL STORES JETTISON BUTTON—DEPRESS. (If required)**

Note

Nuclear stores will not be jettisoned.

3. **HOOK—EXTEND. (If required)**
4. Shoulder harness—Locked.

ABORTED TAKEOFF (WET OR DRY RUNWAY).

Full pedal deflection anti-skid braking with control stick full aft and centered will give the most effective deceleration for both dry and wet runways at normal take-off gross weights. Nose wheel steering may be used throughout the roll, except during barrier engagement. The chances for a successful barrier arrestment are greatly reduced by tire failure (blowout). The rim of the affected wheel normally snags or damages the cable, causing a missed engagement or cable failure. When a barrier engagement is anticipated, brake application of a severity great enough to cause tire blowouts should be avoided. Wet runway aborts are essentially the same as dry runway aborts with a noticeable exception: nose wheel steering and differential braking may be necessary to maintain directional control.

WARNING

Hot brakes will usually occur during any maximum braking abort, wet or dry. Refer to "Brake Energy Limits," Section V. Do not set parking brakes after a maximum braking abort.

Note

It is recommended that the heels be located below the pedals prior to brake application for wet runway aborts to prevent the foot from sliding up on the pedal during large differential rudder deflection.

BARRIER ENGAGEMENT.

On center engagements of the BAK-9, BAK-12, extended runout BAK-12, dual BAK-12, and BAK-13 barrier present no special problem to the aircrew. Tests show that with off center engagement the aircraft will be pulled to the "off center" side of the runway during the run out. Barrier contact should be made with nosewheel steering disengaged. No attempt to correct yaw or roll tendencies during the arrestment should be made until the aircraft is slowed sufficiently to insure aircraft control. Due to inherent stretch characteristics of the nylon tape used on the BAK-12, extended runout BAK-12, and BAK-13 barriers, a roll back occurs at the end of the tape run out. The aircraft will be rolled backwards from 10 to 200 feet, depending on the

energy absorbed during the engagement. When roll back occurs after an engagement the aircraft will roll back parallel to the center line of the runway for either "on center" or "off center" engagements. Roll back may be shortened by the use of even braking; however, difficulties may be experienced in maintaining aircraft alignment with braking while it rolls back. The following recommended steps will aid in successful barrier engagements:

WARNING

Use of the MA-1 and MA-1A barrier with this aircraft has not been tested, therefore, results of their engagement cannot be accurately predicted.

- Disengage nosewheel steering prior to barrier contact.
- Do not attempt to correct yaw or roll tendencies during the arrestment until the aircraft is slowed sufficiently to insure aircraft control.
- Apply light braking at the end of the arrestment when possible to minimize roll back without causing the aircraft to pitch up.

ENGINE FAILURE DURING TAKEOFF.

If Decision Is Made To Stop:

1. **ABORT.**
   Refer to "Abort/Barrier Engagement" procedures, this section.

If Takeoff Is Continued:

1. **THROTTLES—MAX.**
2. **EXTERNAL STORES JETTISON BUTTON—DEPRESS. (If required)**

Note

Nuclear stores will not be jettisoned.

3. Maintain takeoff speed until obstacles are cleared.
4. Landing gear handle—UP, when safely airborne.
5. Air source selector knob—OFF. (If required)

Note

- Significant thrust is gained with the air source selector knob OFF.
- With air source off, no servo air will be available for throttle boost or fuel tank pressurization. Lack of tank pressurization will degrade fuel dump rate.

6. Fuel dump—As required.
7. Flap/slat handle—As required.
   a. Flap/slat retraction—Maintain established pitch attitude and retract flaps/slats at a rate to maintain 8.5 degrees angle-of-attack.

WARNING

Excessive angle-of-attack may result from retracting flaps too rapidly.

Note

A normal reduction of rudder authority will occur as slats are retracted. This may be felt as a kick-back on the rudder if more than 7.5 degrees rudder deflection is being held.

8. Air source selector knob—As required.
9. Throttle of failed engine—OFF.
10. Attempt airstart if failure was nonmechanical and engine appears normal.
11. Land as soon as practicable.

SINGLE ENGINE RATE OF CLIMB.

Due to temperature, pressure altitude, gross weight, pilot technique, etc., the time and distance required to accelerate to best single engine climb speed is widely variable. The altitude attainable at a specific close-in obstacle is unpredictable unless takeoff speed is maintained until such obstacles are cleared. After close-in obstacles are cleared, maintain an attitude which will clear terrain and accelerate to best single engine climb speed. This speed will equate to 8.5 degrees angle-of-attack. Maintain established pitch attitude and retract the flaps/slats at a rate to maintain 8.5 degrees angle-of-attack.

ENGINE FIRE DURING TAKEOFF.

If Decision Is Made To Stop:

1. **ABORT.**
   Refer to "Abort/Barrier Engagement" procedures, this section.

If Fire Persists:

2. Fire pushbutton—Depress.
3. Agent discharge—Actuate.
4. Abandon the aircraft.

If Takeoff Is Continued:

WARNING

With any engine fire indication, immediate and positive steps must be taken to shut off fuel/hydraulic supply and extinguish the fire. Otherwise, the flame may be drawn into the rudder actuator bay area resulting in damage to the rudder control system and subsequent loss of control.

1. **THROTTLE GOOD ENGINE—MAX.**
2. **FIRE PUSHBUTTON—DEPRESS.**

WARNING

- Use caution to prevent inadvertently depressing the wrong pushbutton and shutting down the good engine. Even though the button may be depressed again to open the fuel shutoff valve and allow restarting the engine, the hydraulic shutoff valves cannot be reopened to provide hydraulic power for flight control system operation.
- Depressing the engine fire pushbutton the second time will reopen the fuel shutoff valve and disarm the fire extinguisher agent discharge valve.

3. **AGENT DISCHARGE—ACTUATE.**
4. **EXTERNAL STORES JETTISON BUTTON—DEPRESS.** (If required)

Note

Nuclear stores will not be jettisoned.

5. Throttle bad engine—OFF.
6. Landing gear handle—UP, when safely airborne.
7. Maintain takeoff speed until obstacles are cleared.
8. If fire is confirmed and continues—Eject.

If Fire Is Extinguished:

9. Air source selector knob—OFF. (If required)

Note

- Significant thrust is gained with the air source selector knob in OFF.
- With air source off, no servo air will be available for throttle boost or fuel tank pressurization. Lack of tank pressurization will degrade fuel dump rate.

10. Fuel dump—As required.

Note

If dumping operation is necessary during afterburner operation, the fuel may ignite behind the aircraft. This should cause no concern however, since the fire will remain behind the aircraft. Observers may interpret this as an aircraft fire.

11. Flap/slat handle—As required.
    a. Flaps/slats retraction — Maintain established pitch attitude and retract flaps/slats at a rate to maintain 8.5 degrees angle-of-attack.

WARNING

Excessive angle-of-attack may result from retracting flaps too rapidly.

Note

A normal reduction of rudder authority will occur as slats are retracted. This may be felt as a kick-back on the rudder if more than 7.5 degrees rudder deflection is being held.

12. Air source selector knob—As required.
13. Land as soon as possible.

AFTERBURNER FAILURE DURING TAKEOFF.

Full afterburner thrust will be required for normal takeoff. If afterburner fails during takeoff the thrust loss is significant. Abort the takeoff if failure occurs prior to being committed to takeoff. If failure occurs after takeoff is committed, attempt to regain AB by recycling the throttle to MIL and back to AB.

TIRE FAILURE DURING TAKEOFF.

Directional control is not difficult with a blown tire if nose wheel steering and differential braking are used properly. The aircraft will lean significantly to the side of the blown tire. The brake on the good tire should be used normally. Do not lock the brake on the wheel with the blown tire.

If Decision Is Made To Stop:

1. **ABORT.**
   Refer to "Abort/Barrier Engagement" procedures, this section.
2. Nose wheel steering—Engaged.

If Takeoff Is Continued:

1. External stores jettison button—Depress. (If required)

Note

Nuclear stores will not be jettisoned.

2. Do not retract landing gear.

CAUTION

If gear is retracted with a blown tire, possible damage to the wheel well area may occur.

3. Instruments—Check.
   Check hydraulic, fuel and engine instruments to determine possible damage resulting from the disintegrated tire.
4. Fuel dump—As required.
5. Land as soon as practicable.

FLAT MAIN STRUT DURING TAKEOFF.

The first indication of a flat main gear strut will be a drop in the wing on the side of the flat strut. Directional control will be less difficult than with a blown tire and stores ground clearance will not present a problem. If a flat main strut is experienced, follow the procedures under "Tire Failure During Takeoff," this section.

LANDING GEAR RETRACTION MALFUNCTION.

LANDING GEAR UP AND LOCKED INDICATION NOT OBTAINED.

If after 15 seconds following landing gear up selection the landing gear warning lamp remains lighted:

1. Landing gear control circuit breakers—Check.
2. Speedbrake switch (left crew station)—In.
   Recycle speedbrake to correct possible out-of-sequence condition.
3. Speedbrake hydraulic valve circuit breaker—Pulled, then reset.
4. Obtain visual confirmation of landing gear position if possible. Check for possible malsequence of nose gear and uplock malsequence.
5. Do not recycle the landing gear.

WARNING

Recycling of the landing gear could result in damage to the gear, nose wheel steering mechanism, or the aircraft.

If The Landing Gear Warning Lamp Is Still Lighted:

6. Landing gear handle—DN. Obtain visual confirmation of landing gear position, if possible.
   a. If normal indications are not present, refer to "Landing Gear Malfunctions", this section.
   b. If normal indications are present, check landing gear doors, struts, steering linkages, and tires for proper extension, alignment, and security.
7. If any gear or steering abnormality exists or is suspected, an approach end barrier engagement is recommended. Refer to "Approach End Barrier Engagement" this section.

INFLIGHT EMERGENCIES

CAUTION LAMP ANALYSIS.

See figure 3-5 for analysis and suggested corrective action to be taken whenever a caution lamp is lighted.

AIR CONDITIONING SYSTEM MALFUNCTIONS.

CABIN OVERHEAT.

If Uncontrolled Cabin Overheat Occurs, Try To Close The Cabin Warm Air Valves As Follows:

1. Mode selector knob—OFF.
2. Air source selector knob—OFF.
   Immediately descend and decelerate to the "Ram or Emer Mode Flight Limits", Section V.
3. Air source selector knob—EMER.

Note

- For supersonic flight under conditions of high total temperature readings, placing the air source selector knob to EMER or RAM will result in excessive cabin temperature.
- With air source in EMER or OFF, servo air will not be available for throttle boost, fuel tank, or cabin seal pressurization.

If Cabin Temperature Is Still Uncontrollable In EMER:

4. Air source selector knob—OFF.

If Cabin Overheat Continues:

5. Left engine—Reduce to IDLE power.

If Cabin Overheat Persists:

6. Left engine—Power as required.
7. Right engine—Reduce to IDLE power.

If hot airflow is not reduced to a bearable level, reduce airspeed. (10 degrees angle-of-attack with full flaps)

The Following May Be Used As A Last Resort:

8. Canopy—Open one or both. (Be prepared for wind blast)
9. Land as soon as practicable.

CABIN TOO COLD.

Excessive Cooling: (High Air Flow)

If the cabin temperature becomes uncontrollably cold due to excessive cooling airflow in the MANUAL or AUTO modes, cabin cooling airflow can be reduced as follows:

1. Air source selector knob—L ENG.
2. Left engine—Reduce to IDLE power.
3. Right engine—Power as required.
4. ECM selector knobs—ON. (All 3 bands)

Loss of Heating: (Low Air Flow)

If the cabin temperature becomes uncontrollably cold in the MANUAL or AUTO modes due to a loss of heating airflow:

1. Set power on one engine (left or right) to MIL for 20 seconds, then return as required.

EJECTION.

Every emergency in which ejection is considered will have its particular set of circumstances, involving such factors as speed, attitude and control, and altitude. Under level flight conditions, eject at least 2000 feet above the terrain whenever possible.

WARNING

Do not delay ejection below 2000 feet above the terrain in futile attempts to start the engines or for other reasons that may commit you to marginal conditions for safe ejection. Accident statistics emphatically show a progressive decrease in successful ejections as altitude decreases below 2000 feet above the terrain.

Under uncontrollable conditions, eject at least 15,000 feet above the terrain whenever possible. If the aircraft is controllable, attempt to decelerate as much as practical prior to ejection by zooming the aircraft, thus trading airspeed for altitude. If the aircraft is not controllable, ejection must be accomplished at whatever speed exists, as this offers the only opportunity for survival. An ejection at low altitudes is facilitated by pulling the nose of the aircraft above the horizon ("zoom-up maneuver"). This maneuver affects the trajectory of the crew module, providing a greater increase in altitude than if ejection is performed in a level flight attitude. Provided a positive rate of climb is maintained, this gain in altitude will increase the time available for complete actuation of the ejection equipment. To ensure survival during extremely low-altitude ejections, the automatic features of the equipment must be used and depended upon. As with all aircraft ejection systems, safe ejection is enhanced by establishing the best conditions possible prior to ejection. For "Ejection Procedures", "Minimum Terrain Clearance For Ejection", and "Crew Module Ejection Sequence" see figures 3-1 and 3-2.

WARNING

- Under certain conditions of crew module weight and/or tail wind, zero altitude and zero airspeed ejection capability may be prejudiced. Because of the variables involved, ejection should not be attempted at zero altitude with less than 50 KIAS.
- When ejection is necessary with a known or suspected pitot-static failure, every attempt should be made to slow the aircraft to below an estimated 300 knots. At aircraft gross weights up to 100,000 pounds and with the wings forward of 50 degrees, a 10 degree or greater angle-of-attack in one "g" stabilized flight will ensure that the airspeed is below 300 knots. *At altitudes above 20,000 feet MSL,* slowing the aircraft before ejection is less critical but is still recommended. In all cases, ejection should be initiated before stall/departure is reached.
- Ejection performance is valid only when crew module gross weight and center-of-gravity is within limits specified in T.O. 1-1B-40 and *reflected in Form* 781.

BEFORE EJECTION (IF TIME PERMITS).

1. Reduce airspeed (as practicable).
2. Advise crew member of situation.
3. Transmit MAYDAY (give position).
4. IFF master control knob—EMER.
5. Chaff dispenser control lever—ON. (OFF for tactical considerations only)
6. *Oxygen—100 percent.*
7. Inertial reel control handle—LOCKED.
8. Oxygen mask and fittings—On and checked. Keep mask on during ejection and descent.
9. Adjust seat full down and aft.

Crew Module Ejection Sequence
(Typical Low Speed Ejection)

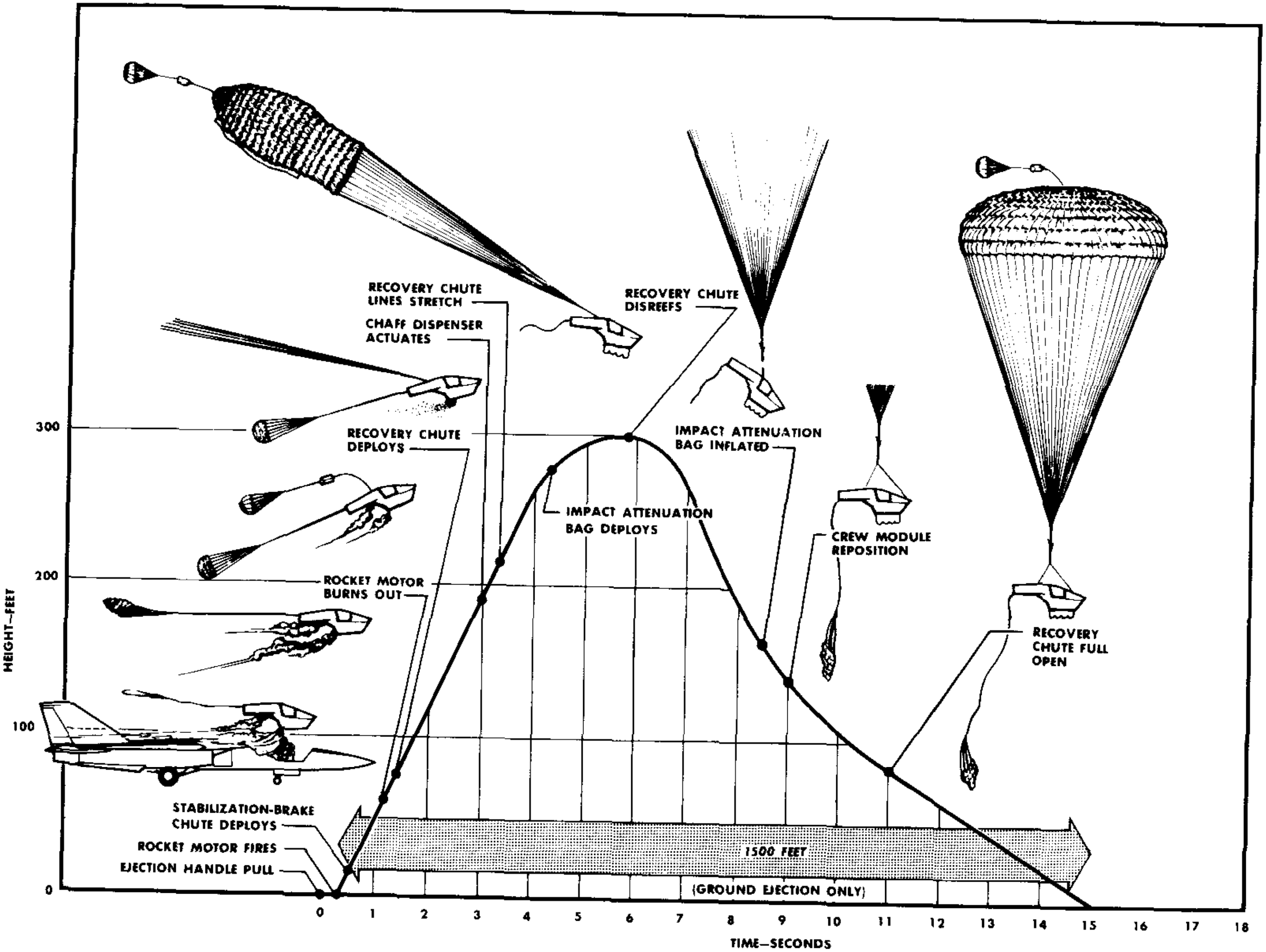
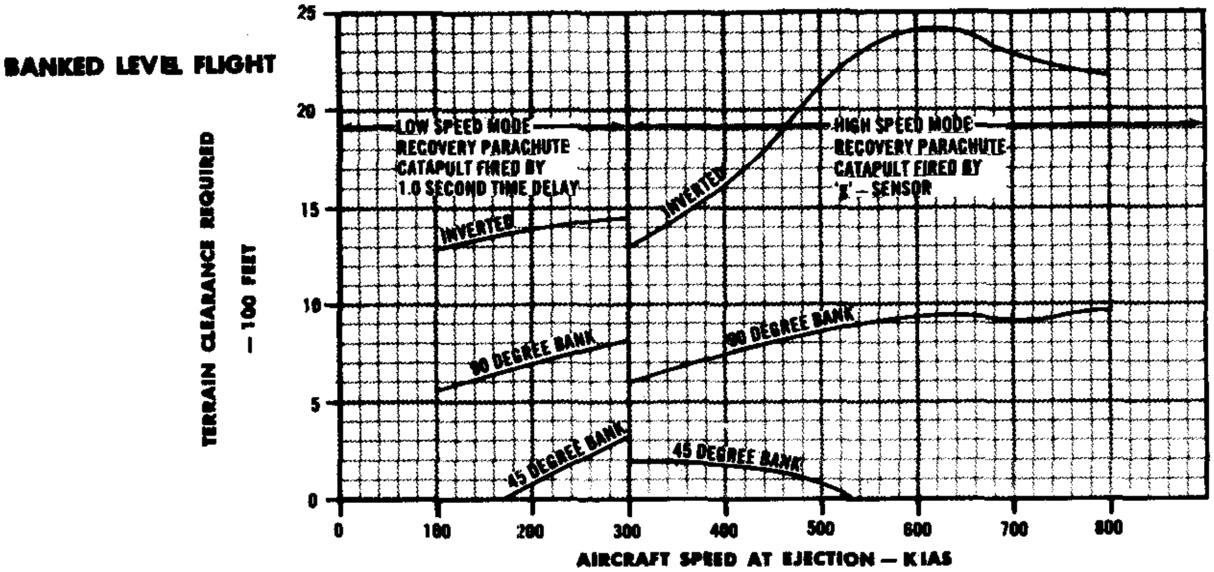


Figure 3-1.

Minimum Terrain Clearance For Ejection

DATA BASIS: ESTIMATED

1. CREW MODULE GROSS WEIGHT AND C.G. WITHIN LIMITS SPECIFIED IN T.O. 1-1B-40.
2. INITIAL YAW ANGLE LESS THAN 5 DEGREES FOR SPEED BELOW 500 KNOTS AND LESS THAN 1 DEGREE FOR SPEED ABOVE 500 KNOTS.
3. SEA LEVEL ALTITUDE.
4. FOR DIVING TURNS THE CLEARANCE REQUIREMENTS ARE ADDITIVE PLUS 300 FEET.
5. NO ALLOWANCE FOR CREW REACTION TIME INCORPORATED.



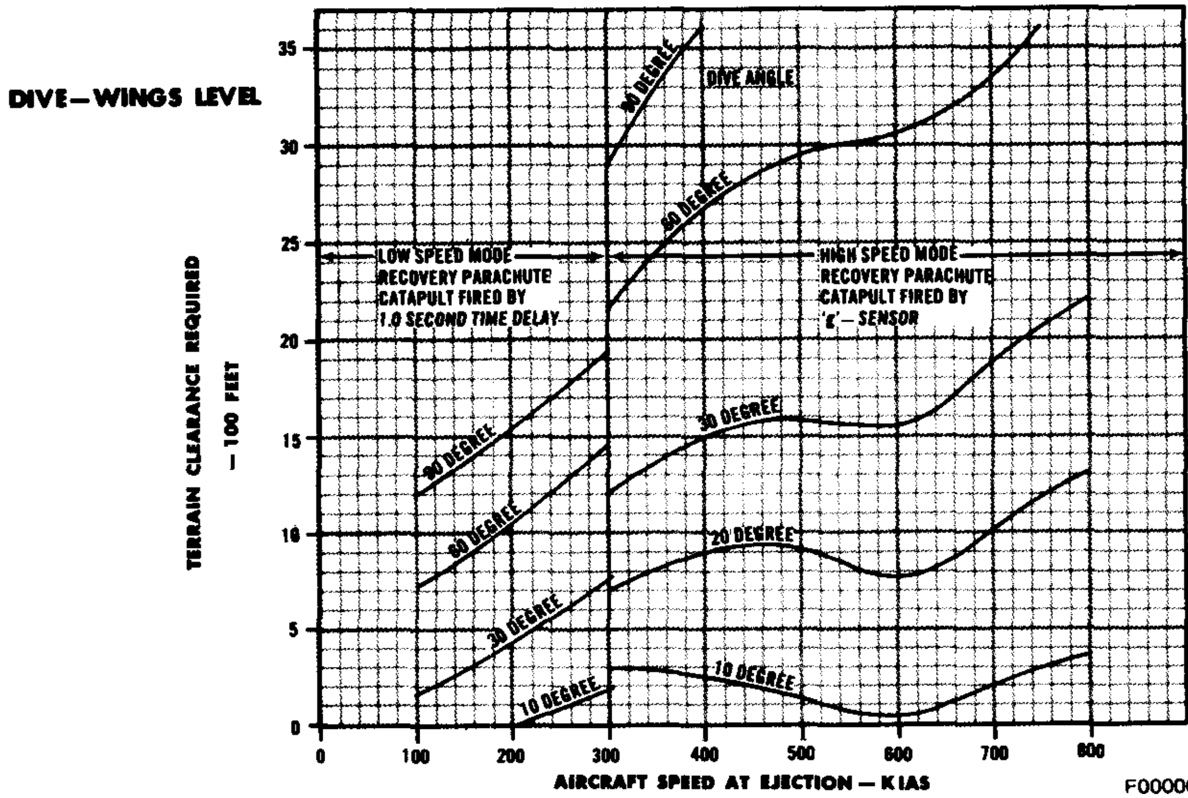


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Figure 3-2.

EJECTION.

1. **EJECTION HANDLE — SQUEEZE AND PULL.**

WARNING

- A three tenths of a second delay should be expected between the time the ejection handle is pulled and the rocket motor fires. This delay allows the inertia reels to retract and lock the crew member in the upright position. Injury could occur if the crew member is not in a firm upright position with head against headrest when ejection is initiated. Ejecting with the seat high enough to cause the shoulders or back to contact the headrest will increase probability of spinal injury.
- To prevent possible injury during landing, restraint harness should be cinched tight during descent and remain tight until module comes to rest after impact.

DURING DESCENT.

1. Emergency oxygen handle—Pull. (If required)
2. Oxygen control knob — EMER or 100%. (If required)
3. Parachute deploy handle (when below 15,000 feet ~~as indicated by the standby altimeter)~~—Pull. (If required)

155-11

WARNING

If ejection occurs above 15,000 feet, do not actuate the parachute deploy handle until passing through that altitude, if terrain elevation permits, to prevent loss of recovery parachute and to assure sufficient oxygen supply. If ejection occurs below 15,000 feet, allow at least five seconds prior to actuating the deploy handle to assure that the module is clear of the aircraft and to allow deceleration of the module. Do not attempt to beat the system.

Note

- Oxygen mask should be on prior to impact.
- If smoke or fumes are present in the cockpit, they should be vented by opening canopy hatch(es) as soon as the main parachute has deployed. The hatch(es) must be closed and locked prior to impact.

AFTER LANDING.

Note

The right self-righting bag will start to inflate approximately 75 seconds after the severance and flotation handle is pulled. When the right hatch is not opened prior to inflation, the bag will overlap the hatch and must be deflated to fully open the hatch. Egress can be accomplished by opening the hatch partially and puncturing the bag or by exiting through the left hatch.

Ground Landing.

1. Severance and flotation handle—Pull.
2. Parachute release handle—Pull. (If required)
3. Canopy hatch(es)—Open.

WARNING

Crew exposure to toxic gas resulting from ejection in the unventilated cabin is limited to 15 minutes after the oxygen supply is exhausted.

Note

After descending below 8000 feet in an ejected crew module it is possible that atmospheric pressure differential on the canopy will prevent them from being opened. To eliminate this pressure differential, remove the caps from the air mask connector valve (if installed) and push in on the exposed tube. This should be done on the ground only after the module has come to rest, due to the location of the ventilation ports. 155-8 ADDED

If crew module lands inverted:

4. Inertia reel control handle—Cycle to relieve tension.
5. Single point harness release—Rotate 90 degrees, either direction.
   Use caution because lap and shoulder straps will release simultaneously, requiring crew member to support himself.
6. Open canopy hatch as far as possible and lock in place by moving the latch handle to lock detent (midpoint) position.

Water Landing.

1. Severance and flotation handle—Pull.
2. Parachute release handle—Pull.
3. Canopy hatch(es)—Open.

WARNING

Crew exposure to toxic gas is limited to 15 minutes after oxygen depletes. In the event of ejection over water, if it is necessary for crew members to remain in the module for an extended period of time awaiting recovery both canopies should be opened approximately every three hours for ventilation.

4. Bilge pump—Engage and operate. (If required)
5. Auxiliary flotation handle—Pull. (If required)

Note

Survival two way radio antenna must be projected out of the module in order to function properly.

ENGINE EMERGENCIES INFLIGHT.

SINGLE ENGINE FAILURE.

Nonmechanical Failure.

1. Attempt airstart.
   If the engine failure is attributed to something other than a mechanical failure, an airstart may be attempted. Follow "Airstart" procedures, this section.

Mechanical Failure.

1. Throttle of affected engine—OFF.
2. Land as soon as practicable using "Single Engine Landing" procedures.

SINGLE ENGINE FLIGHT CHARACTERISTICS.

Single-engine flight characteristics are essentially the same as the normal flight characteristics due to the proximity of the thrust lines to the center of the aircraft. With one engine inoperative, slight rudder deflection is required to prevent yaw toward the failed engine. The aircraft design is such that no one system is entirely dependent upon a specific engine, thus loss of one engine will not result in the loss of a complete system. Aircraft service ceiling and/or range for single-engine operation (military or afterburner thrust) is a function of aircraft configuration and gross weight. For best range, set military power on the good engine (observing TIT limits) and maintain approximately 285 KIAS, 26 degree wing sweep and allow aircraft to descend to but not below best single-engine cruise altitude as shown in Appendix I. As a rule of thumb, when descent is made using this power setting and airspeed, the best single-engine cruise altitude is that altitude where rate-of-descent stops. If a climb is required, best range can be obtained by anticipating altitude requirements in advance so as to allow a gradual climb with minimum change to power setting (285 KIAS). If time does not permit a gradual climb, use afterburner thrust on the good engine (trading range for altitude). During single-engine operation with various landing gear and wing flap configurations, care must be exercised to avoid rapid airspeed bleed-off and/or excessive sink rates. Limited thrust available makes airspeed response to power much slower than normal two-engine operation.

DOUBLE ENGINE FAILURE.

1. Fuel panel—Checked.
2. Throttles—As required.
3. Airstart button(s)—Depress.
4. Eject. (If airstart cannot be accomplished)

AIRSTART.

Satisfactory airstarts may be accomplished throughout the flight envelope. Approximately 300 KIAS may be required for ram airstarts. Below these airspeeds, engine crossbleed may be required to restart an engine.

Note

- The engine is equipped with auto ignition and will normally restart automatically. If the engine has flamed out because of other problems such as fuel starvation, the following procedure is recommended for airstarting.
- If the throttle has been retarded below IDLE position, the airstart ignition button must be depressed to provide 55 seconds of ignition to the engine to be restarted.
- *A hung start may occur if restart is attempted* with TIT above 400 degrees centigrade. In this event, retard throttle of the affected engine to OFF and allow TIT to decrease below 400 degrees before attempting another restart.

1. Fuel panel—Checked.
   Check fuel feed selection and fuel quantities to assure that fuel is available to the engine.
2. Throttle of affected engine—OFF.
3. Throttle of affected engine—IDLE.
4. Airstart ignition button—Depress momentarily.
   Check for relight within 20 seconds.
5. Generator switch of affected engine—OFF-RESET, START (pause), then release to RUN.
   If the generator caution lamp remains lighted, after engine start, place the generator switch to OFF-RESET, then to START (pause), then release to RUN and check that the lamp goes out and the power flow indicator reads NORM.

Note

The generator switches are lever-locked in OFF-RESET, spring-loaded from START to RUN, and the generator caution lamp will go out when the switch is held in START.

If Airstart Has Not Been Accomplished By The Time Engine RPM Is Below 16 Percent:

6. Throttle of affected engine—OFF.
7. Engine ground start switch—PNEU.
8. Throttle of affected engine—Start position.
9. Throttle of affected engine (at 17 percent)—IDLE.
   Check for relight within 20 seconds.

10. Generator switch of affected engine—OFF-RESET, START (pause), then release to RUN.
    If the generator caution lamp remains lighted place the generator switch to OFF-RESET, START (pause), then release to RUN and check that the lamp goes out and the power flow indicator indicates NORM.
11. If start is not obtained:
    a. Emergency generator switch—As required.
       The emergency generator switch should be left in AUTO to prevent a drain on the hydraulic system when flight is being conducted under visual flight conditions. Emergency electrical power will be available within 1 second if the other generator fails. Position switch to ON during instrument flight and prior to descent for night landings.
    b. Engine ground start switch—OFF.

ENGINE STALL.

In the event of engine stall on one or both engines, proceed as follows:

1. Throttle of affected engine(s):
   a. If in AB—Retard to MIL.
   b. If at MIL or below do not change power setting. When engine recovers, select desired power.

Note

- In the event that a compressor stall and/or afterburner blowout occurs in afterburner operation, but fully stalled engine condition does not follow, an afterburner relight from MIL power may be initiated at any flight condition.
- In order to reduce the incidence of engine compressor stalls, rapid throttle excursions from MAX AB to IDLE should not be attempted above 35,000 feet pressure altitude subsonic, and any altitude at airspeeds above 1.9 mach.

If Stall Does Not Clear Within 10 Seconds:

2. Shut down stalled engine (one only). Note that rpm is decreasing.
3. Perform airstart and set power as desired.

If Stall Is Not Cleared By Above Procedure:

4. Shut down stalled engine a second time. Note that rpm is decreasing.
5. Decelerate to below mach 0.90 or 415 KIAS, whichever is less.
6. Perform airstart and set power as desired.

ENGINE FIRE DURING FLIGHT.

WARNING

With any engine fire indication, immediate and positive steps must be taken to shut off fuel/hydraulic supply and extingish the fire. Otherwise, the flame may be drawn into the rudder actuator bay area resulting in damage to the rudder control system and subsequent loss of control.

1. **FIRE PUSHBUTTON—DEPRESS.**

WARNING

- Use caution to prevent inadvertently depressing the wrong pushbutton and shutting down the good engine. Even though the button may be depressed again to open the fuel shutoff valve and allow restarting the engine, the hydraulic shutoff valves cannot be reopened to provide hydraulic power for flight control system operation.
- Depressing the engine fire pushbutton the second time will reopen the fuel shutoff valve and disarm the fire extinguisher agent discharge valve.

2. **AGENT DISCHARGE—ACTUATE.**

Note

Do not attempt restart.

3. Throttle bad engine—OFF.
4. If fire is confirmed and continues—Eject.

Note

Trailing smoke as viewed by another aircraft or ground observer may be used as an indication of fire. Engine smoke should not be confused with an engine or aircraft fire.

5. If fire ceases, land as soon as possible using "Single Engine Landing" procedures.

SAFE JETTISON PROCEDURES.

In the event an aircraft emergency precludes landing with bombs/missiles aboard or Command Tactical Doctrine procedures dictate a safe release of nonexpended weapons, perform the following checklist.

WARNING

External fuel tanks must have been jettisoned prior to jettisoning of external weapons.

JETTISON PREPARATION (NUCLEAR).

1. SAC command post—Contacted. (If applicable)

Note

For bombs/missiles in a Tactical Ferry or Deployment/Dispersal/Recovery configuration, monitor and control with the DCU-137/A control panel is not possible.

2. Stores control panel:
   a. Master switch—ON.
   b. Delivery mode knob—SRAM MAN. (missile jettison)
   c. Selector mode knob—NUC WPN.
   d. Station select switch—Deselected.
      Deselect all bomb/missile loaded stations or check stations deselected if Prearming has not been performed.
   e. Delivery mode knob—OFF.
3. Nuclear consent switch—OFF, guard down.
4. DCU-137/A control panel:

Note

The DCU-137/A panel checks need not be accomplished when bomb/missile monitor and control is not available or if a nuclear payload is not installed in missile.

   a. Option select switch—MON.
   b. Monitor lamps—Checked (N).
      Rotate monitor and release knob to each nuclear loaded station and check lamp indications: SAFE lamp lighted, all others out except ENABLE lamp lighted for B-61 or B-43/B-57 PAL bombs.
   c. Monitor and release knob—OFF (N).
   d. Option select switch—OFF (N).

Note

If bombs cannot be electrically safed, they will be retained aboard the aircraft.

STATION JETTISON (NUCLEAR).

Note

Accomplish the following only after arrival over authorized jettison area.

1. Nuclear consent switch—REL ONLY.
2. Stores control panel:
   a. Delivery mode knob—AUX.
   b. Selector mode knob—STA JETT.
      Other jettison modes may be used in the event of release system or malfunction or special requirements.
   c. Station select switches—Selected.
      Check that the station select lamps are lighted for stations to be jettisoned.
3. DCU-137/A panel:
   a. Option select switch—MON.
   b. Monitor lamps—Checked.
      Rotate monitor and release knob to stations selected for jettison and check that the SAFE and UNLOCK monitor lamps are lighted.
   c. Monitor and release knob—OFF.
   d. Option select switch—OFF.
4. Impact area—Clear.
   Clear impact area both visually and by radar to the maximum extent possible.
5. Stores control panel:
   a. Bay doors—OPEN. (If applicable)
   b. Release enable switch—RELEASE ENABLE.
   c. Weapon release button—Depressed.
      Depress either the pilot's or navigator's weapon release button.
   d. Weapon present and station select lamps—Out.
   e. Weapon bay doors—Closed.
   f. Release enable switch—INHIBIT.
6. AGM-69A control and display panel malfunction and status lamps—Out.

WARNING

If a non-nuclear burst occurs, aircraft damage may result unless bombs are released at least 500 feet above the surface.

7. Bomb/missile jettison radio call—Accomplished.
   a. Geographical location at time of bomb/missile jettison.
   b. Type of cargo "dangerous" or "inert."
   c. Type of burst.
   d. Crew intentions as to bailout, ditch, or crash land.

EMERGENCY EXTERNAL STORES JETTISON (NON-NUCLEAR).

WARNING

This procedure will not be used to jettison fuel tanks subsequent to nuclear weapon prearming.

All external non-nuclear weapons and fuel tanks can be jettisoned if an emergency requires the immediate reduction of weight and drag. Such condition would normally occur on takeoff. Switch positions prior to

weapon prearming, including nuclear consent switch OFF, will prevent release of weapons during nuclear carriage if fuel tank jettison is required. Pre-takeoff procedures include positioning of switches to enable emergency ground jettison of non-nuclear bombs, missiles without a nuclear warhead installed, and/or fuel tanks on aircraft modified by T.O. 1F-111(B)A-591. Ground jettison cannot be accomplished on aircraft prior to T.O. 1F-111(B)A-591. Emergency jettison of fuel tanks should be accomplished within the following conditions:

- Fuel tanks—Empty or with more than 1800 pounds fuel remaining.
- Wing sweep—16 to 26 degrees.
- Gear and flaps—Up or down.
- Altitude—Below 10,000 feet.
- Airspeed—Below 300 KIAS.
- Speed brake—Retracted. (If gear is up)

CAUTION

- The flaps may be damaged if stores are jettisoned with flaps down.
- When the stores are jettisoned, interstores collision may result in damage to the aircraft.

1. External stores jettison button—Depressed.

SELECTIVE STORE JETTISON (NON-NUCLEAR).

Note

- Three options are available for selective jettison: (1) WPN JETT, (2) PYLON JETT, and (3) STA JETT. The desired option is selected by positioning the selector mode knob on the stores control panel. For PYLON JETT, symmetrically paired stations must be selected before a jettison can occur.
- WPN JETT is available for wing stations only after T.O. 1F-111(B)A-620.

1. SAC command post—Contacted (If possible).
2. Open ocean (if possible) uninhabited area—Selected.

   The impact area must be clear visually and by radar to the maximum extent possible.
3. Stores control panel:
   a. Master switch—ON.
   b. Delivery mode knob—AUX.
   c. Station select switches—Applicable stations selected, all others deselected.
   d. Selector mode knob—Applicable jettison position.
   e. Bay door control switch—OPEN. (If applicable)
4. Nuclear consent switch—REL ONLY. (As applicable)
5. Release enable switch—RELEASE ENABLE.
6. Weapon release button—Depressed.
7. Release enable switch—INHIBIT.

FLAP/SLAT MALFUNCTIONS.

If the flaps stop at an intermediate position during retraction or extension, a likely cause is a dislodged or broken flap vane. Further flap actuation could result in extensive flap damage or loss of the malfunctioning flap vane. It is recommended that further flap operation not be attempted, and a landing made with the existing flap setting, provided landing conditions are acceptable (RCR, ceiling, etc.). Placing the flap/slat system selector switch to EMER will relieve hydraulic pressure to the flap motor and could prevent further damage. If marginal flaps-up landing conditions exist, flap extension may be attempted. If practical, this should be accomplished over a designated drop area or unpopulated area. If landing is made with existing flap position, refer to "Landing With Partial Flaps," Section II.

ASYMMETRIC SLAT.

If it is determined that an asymmetric slat extended condition exists, proceed as follows:

1. Flap/slat handle—Position to obtain symmetric slat extension.

   Extend or retract slats, monitoring operation, in an attempt to obtain equal slat deflection on each side, and check for a reduction in degree of rolloff.

CAUTION

Do not place the flap/slat handle beyond the SLAT DOWN position. If asymmetrical slat extended condition exists, and the flap and slat handle is in FLAP DOWN or the flap and slat switch is in EMER, upon initial travel of the flaps the asymmetry device will cause the torque shaft brakes to engage preventing any further flap or slat movement.

If Rolloff Is Reduced To Zero:

2. Slat deflection—Checked.

   Check for equal slat deflection on each side. If slats are extended, observe the slats extended airspeed and limit maneuver load factors limitations. With slats extended or retracted, refer to "No Flap Landing," this section.

If Roll Off Is Still Present:

3. Observe the slats extended airspeed and limit maneuver load factors limitations and refer to "Landing with Asymmetric Slat," this section.

ASYMMETRIC FLAP.

An asymmetric flap condition probably exists if during takeoff or landing when flaps are retracted or extended, the aircraft starts to roll off. Flight controls should be applied as required to maintain wings level and the flap/slat handle should be returned toward its previous position (25 degrees for takeoff or UP for landing) until rolloff stops. This should place the flaps back in a symmetrical condition. For asymmetric flap condition proceed as follows:

1. Flap/slat handle—Return towards previous position until rolloff stops.
2. Fuel dump—As required.
3. Land as soon as practical. Refer to "No Flap Landing," this section.

FLIGHT CONTROL SYSTEM MALFUNCTIONS.

Note

The flight control system emergency procedures presented in this section are the immediate steps required to correct critical abnormal flight characteristics. The sequence of these steps is determined by the degree of emergency. It may not be necessary to accomplish the complete procedure to correct a particular malfunction.

Various flight control system malfunctions are indicated by the lighting of an associated caution lamp. Refer to figure 3-5 for analysis of all caution lamps.

LOW FREQUENCY OSCILLATIONS IN PITCH OR ROLL AXIS.

Although the pitch and roll gain changers are redundant, certain malfunctions may occur which cause the pitch or roll adaptive gain to become high enough to cause the pitch or roll damper servo to drive the horizontal tails in a limit cycle oscillation at a frequency between 1.7 and 3 cps. Under certain conditions, this oscillation may also appear in the control stick. A decrease in airspeed or increase in altitude will alleviate the oscillation. The pitch or roll gain can be reset to its minimum value by cycling the appropriate damper switch to OFF and back to DAMPER. If oscillation occurs proceed as follows:

1. Decrease airspeed or increase altitude, and/or cycle the appropriate damper switch to OFF and return to DAMPER.

Note

Momentarily cycling the damper switch to OFF does not necessitate going to the "Damper Off" operating region.

UNSCHEDULED PITCH PARALLEL TRIM.

A malfunction in the pitch parallel trim system will cause the trim to drive nose up or down and will be evidenced by the stick driving at a normal system rate. If condition occurs proceed as follows:

1. Auxiliary pitch trim switch—OFF, then trim nose up or down as required.
2. Leave auxiliary pitch trim switch out of the stick position for remainder of flight.
3. Terminate pitch autopilot, manual and auto TF operation.
4. Land as soon as practicable.

UNSCHEDULED SERIES TRIM.

Malfunctions within the series trim circuits can cause the actuator to stop, or drive nose up or down. The maximum rate of drive will be approximately 1.4 degrees per second. Series trim driving will not cause the control stick to be driven. For unscheduled driving of the series trim proceed as follows:

1. Control stick trim button—Trim parallel trim to counter the maneuver.
2. Terminate pitch autopilot, manual and auto TF operation.
3. Land as soon as practicable.

UNSCHEDULED ROLL TRIM.

Should a malfunction occur in the roll trim circuit, it can be overcome by initially applying stick force. Placing the roll damper OFF will remove the roll trim input. If unscheduled roll trim is encountered proceed as follows:

1. Roll damper—OFF.
2. Flight control disconnect switch—OVRD. (If desired)

Note

If desired, roll trim inputs may be removed by placing the flight control disconnect switch to the OVRD position. Placing the disconnect switch to OVRD position removes the following inputs from the system: pitch and roll autopilot commands, pitch damper trim inputs, TFR climb/dive commands, adverse yaw compensation commands, and pedal shaker inputs.

3. Roll damper switch—DAMPER. (If desired)
   If roll damping is desired after placing flight control disconnect switch to OVRD, return roll damper switch to DAMPER.

UNSCHEDULED YAW TRIM.

Should a malfunction occur during flight in the yaw trim circuit which causes the trim unit to drive hard over, pedal force must be used to oppose the ensuing side slip. The required forces can be reduced by placing the rudder authority switch to FULL position. Should an unscheduled yaw trim condition occur, proceed as follows:

1. Rudder trim—Retrim. (If possible)
2. Rudder authority switch—FULL.
3. Land as soon as practicable.

AUTOPILOT DISCONNECT PROCEDURE.

If a malfunction should occur while on autopilot, the autopilot should be disengaged through use of the autopilot release lever. However, under certain malfunctions, this procedure may not fully suffice. The autopilot switches can be placed to the "DAMPER" position if disengagement has not occurred, then position the flight control disconnect switch to the OVRD position. These actions will terminate autopilot use. If a malfunction occurs, proceed as follows:

1. Autopilot release lever—Depress. (Prior to T.O. 1F-111(B)A-593)
2. Autopilot release/PCSS lever—Depress to second detent. (After T.O. 1F-111(B)A-593)
3. Autopilot damper switches—DAMPER.

If Disengagement Has Not Occurred:

4. Flight control disconnect switch—OVRD.

Note

Placing the flight control disconnect switch to OVRD position removes the following inputs from the system: pitch and roll autopilot commands, roll trim commands, pitch damper auxiliary trim inputs, TFR climb/dive commands, adverse yaw compensation commands, and pedal shaker inputs.

UNSCHEDULED PITCH MANEUVER.

The following procedure applies in event of an unscheduled pitch maneuver that cannot be attributed to a TFR fly-up. This type of maneuver may or may not be abrupt.

1. Autopilot release lever—Depress and hold. (Prior to T.O. 1F-111(B)A-593)
2. Autopilot release/PCSS lever—Depress and hold to second detent. (After T.O. 1F-111(B)A-593)
3. Pitch damper—OFF.
   With pitch damper off, observe damper off limits.

If Control Of The Aircraft Cannot Be Achieved:

4. Eject.

UNSCHEDULED ROLL/YAW MANEUVER.

The following procedure applies in the event of an unscheduled roll/yaw maneuver. This type of maneuver may or may not be abrupt. The maneuver will be characterized by the inability to hold constant heading, a build-up of lateral acceleration, and the requirement for increasing lateral control to maintain wings level flight. For unscheduled roll/yaw maneuvers proceed as follows:

WARNING

Engine stall may occur on one or both engines due to side slip.

1. Autopilot release lever—Depress and hold. (Prior to T.O. 1F-111(B)A-593)
2. Autopilot release/PCSS lever—Depress and hold to second detent. (After T.O. 1F-111(B)A-593)
3. Rudder authority switch—FULL.
4. Roll or yaw damper—OFF. (As required)

Cycle the appropriate damper switch to OFF to check if this eliminates the unscheduled maneuver. If it does, leave the damper OFF; if not, return the switch to DAMPER.

If Control Is Available:

5. Wing sweep — Sweep wings forward to obtain spoilers. (Within airspeed limits)

Sweep the wings forward of 45 degrees to provide spoilers to assist in controlling the roll or yaw maneuver. The wings should be swept slowly when between 50 and 45 degrees in anticipation of a possible abrupt lateral transient when the spoilers are activated, especially if a large lateral control stick displacement is being held to counteract the maneuver.

If Control Cannot Be Achieved:

6. Eject.

HARD-OVER RUDDER.

Experience has shown that hard-over rudder deflection can occur. This condition can be a result of aft fuselage fires or severance of the rudder linkage aft of the feel spring for one reason or another. The ability of the crew to cope with this failure depends on several factors including (1) aircraft configuration — flaps and slats extended or retracted, (2) wing sweep, (3) external store loading, (4) degree of damage to the hydraulic system, (5) availability of approach end barrier or midfield arresting gear, and (6) crew proficiency. Hard-over rudder may be recognized by abrupt, uncommanded, simultaneous nose right yawing and right wing down rolling tendencies. The rudder surface will

be full (30 degrees) trailing edge right. There will be no response to any rudder pedal input although rudder pedal force and travel will be normal. Left wing down bank will be required to maintain a constant heading. The surface position indicators will read erroneously if fire damage to the wires at the actuator has occurred. The primary problem associated with a hard-over rudder is control of the aircraft in roll. Roll control is best with flaps and slats extended, therefore, the flaps and slats, if extended, should not be retracted. Damage to the hydraulic system may adversely affect roll control, so the crew should avoid any unnecessary action which would place heavy demands upon this system, such as cycling landing gear, flaps and slats or sweeping the wings. If a hard-over rudder is suspected with flaps and slats retracted, establish an airspeed of 250-300 KIAS. Approximately 15 to 20 degrees left wing down bank will be required to maintain a constant heading. Do not slow below 250 KIAS since roll control will be extremely marginal at lower airspeeds. Establish an altitude such that safe ejection may be effected if control is lost. Use asymmetric thrust to reduce sideslip. Conditions permitting, selective jettison may be used to jettison right wing store loadings in station order 8-7-6-5 in order to reduce the angle of sideslip and counteract the rolling moment being produced by the hard-over rudder. Prior to descent for landing approach, accomplish the following:

1. Tail hook—Down.
2. Extend slats and flaps by the normal system (emergency extension would minimize hydraulic demand but would require a lower airspeed prior to extension; hence, this is not recommended). Slats and flaps must be extended before slowing to airspeeds below 250 KIAS to insure adequate roll control.
3. Gradually decrease airspeed to determine if control can be maintained at a safe approach speed. Do not exceed 10 degrees angle-of-attack.
4. When approach speed has been established, extend landing gear using emergency system.
   a. Landing gear handle—UP.
   b. Landing gear emergency release handle—Pull. After pulling the emergency release handle, allow time, as practicable, for the gear to fully extend.
   c. Landing gear handle—DN.
   d. Landing gear position indicator lamps—Lighted.
   e. Landing gear handle warning lamp—Out.

Note

If the landing gear handle warning lamp remains lighted, landing gear emergency release handle—In.

If landing is to be attempted and if a choice of runways with a barrier suitable for an approach end engagement is available, select the one with a left cross wind. This will minimize crab angle at touchdown. Perform an approach end barrier engagement. If an approach end barrier is not available, and crab angle at touchdown will be greater than 10 degrees, landing is not recommended. Crab angles in excess of 10 degrees may produce excessive side loads on the landing gear and/or loss of directional control subsequent to touchdown.

FUEL SYSTEM MALFUNCTIONS.

FUEL SYSTEM OPERATION ON EMERGENCY ELECTRICAL POWER.

When operating on the emergency generator, the electrical power provided will operate only one fuel booster pump at a time (number 4 pump in the reservoir tank or number 5 in the aft tank) or the two inboard wing transfer pumps and number 12 transfer pump in the weapons bay tank. The transfer pumps cannot be operated while one of the fuselage booster pumps is operating. When the engine feed selector switch is in FWD, only the number 4 pump in the reservoir tank will be operating and will supply fuel to both engines.

When the engine feed selector switch is in AFT or BOTH, only the number 5 pump in the aft tank will be operating and will supply fuel to both engines. When the engine feed selector switch is in AUTO, either pump 4 or pump 5 will operate depending on fuel distribution. If the fuel differential is greater than 8500 (±125) pounds, number 4 pump will supply fuel to the engines until the differential reduces to less than 8250 (+175 or −200) pounds (minimum fuel quantity fed to engines before shutoff of number 4 pump is 250 (+50 or −75) pounds.) Number 5 pump will then supply fuel to the engines until the differential again increases to 8500 (±125) pounds. The above operation will repeat with the number 4 and 5 pumps alternately supplying fuel to the engines. If, when the AUTO position is initially selected, the fuel differential is less than 7900 (±125) pounds, the number 5 pump will transfer fuel to the forward tank until the proper fuel differential is established. From this point on, either pump 4 or 5 will be automatically selected to supply fuel directly to the engines. During the period that pump 5 is transferring fuel forward, the engines will be operating on suction feed. In order to transfer fuel from the wing or weapons bay tanks, the engine feed selector switch must be turned OFF and the fuel transfer switch placed to WING, BAY, or AUTO. This will result in the engines being fed by suction from the forward tank. Fuselage tank fuel quantities must be closely monitored to maintain the proper distribution during transfer. If distribution gets out of tolerance, it can be correced by positioning the engine feed selector switch to AUTO. During suction feed, the fuel manifold low pressure caution lamps will light. Refer to "Gravity Feed," this section.

Engine Feed.

1. Engine feed selector knob—AUTO.
   Closely monitor fuel quantity in the fuselage tanks to maintain 8200 (±400) pounds fuel differential.
2. Fuel transfer knob—OFF.
3. Fuel tank pressurization selector switch—PRESSURIZE.

Wing Or Weapons Bay Tank Fuel Transfer.

1. Fuel transfer knob—As required.

WARNING

When aft tank boost pumps are not operating, the fuel in the aft tank cannot be transferred. Refer to "Landing with Aft Abnormal Fuel Distribution," this section.

Note

When the wings are swept aft, a larger amount of fuel will be trapped in the wing tanks. To transfer all available fuel from the wing tanks, the wings must be in the extended positions. Gravity transfer of fuel is not possible.

2. Engine feed selector knob—OFF.
   Monitor fuel quantities in the fuselage tanks to maintain a satisfactory fuel differential. Refer to "Gravity Feed," this section.

External Tank Transfer.

External tank fuel can be transferred while on AUTO engine feed.

1. Engine feed selector knob—AUTO.
2. Fuel transfer knob—AUTO.
   Particular tank sets may also be selected by positioning transfer knob to OUTBD, CENTER or INBD.
   Monitor fuel quantity in the fuselage tanks. To maintain 8200 (±400) pounds fuel differential, it may be necessary to periodically position transfer knob to OFF.

Gravity Feed.

During gravity feed, sufficient fuel pressure is available to allow operation within the following ranges of conditions:

1. Military power—Zero to 30,000 feet altitude, up to maximum airspeed with or without fuel tank pressurization.
2. Max AB—Zero to 30,000 feet altitude.
   a. Zero to 300 KIAS—Without fuel tank pressurization.
   b. Zero to 1.30 mach—With fuel tank pressurization.

WARNING

During gravity feed the engines are fed from the forward tank only. Refer to "Abnormal Fuel Distribution/Indication," this section.

Fuel Dump.

1. External fuel tank—Jettison. (If required)

Note

External tank fuel can be transferred while on AUTO engine feed. Refer to "External Tank Transfer," this section.

2. Establish an airspeed of 0.7 mach or less and maintain 1 "g" flight.
3. Position wings slowly to 26 degrees.
4. Engine feed selector knob—AUTO.
5. Airspeed—Established, no greater than 350 KIAS or mach 0.75, whichever is less.
6. Fuel dump switch—DUMP.
7. Fuel distribution—Monitor.
   Fuel will be dumped from the forward tank faster than emergency power can transfer fuel from the aft tank. When the differential fuel distribution between forward and aft tank is approximately 2,000 pounds, stop dumping until the differential approaches 8,000 pounds again.
8. Fuel dump switch—OFF.
9. Engine feed selector knob—OFF.
10. Fuel transfer knob—AUTO.
    When all fuel has been transferred or the fuselage tanks have been refilled, repeat dump procedure beginning with step 6 to obtain desired landing weight.
11. Fuel transfer knob—OFF.
12. Fuel dump switch—OFF.
13. Engine feed selector knob—As required.
14. Land as soon as practicable.

FUEL PRESSURE CAUTION LAMP LIGHTED.

L Fuel Press and/or R Fuel Press Caution Lamp(s) Lighted:

1. Throttles—Set minimum power practical.
2. Engine feed selector knob—Checked.
   Check engine fuel feed selection to insure that fuel is available to the engine(s). Check fuel pump low pressure indicator lamps for evidence of boost pump failure(s) or an empty tank.
3. Fuel tank pressurization selector switch—PRESSURIZE.

If Either/Both Fuel Press Caution Lamp(s) Remain Lighted:

4. Refer immediately to "Excessive Fuel Depletion Procedure," this section.

If The Fuel Press Caution Lamp(s) Do Not Remain Lighted:

5. Check for a possible loss of fuel by comparing:
   a. Planned fuel on board versus actual.
   b. Flowmeters with each other (and against normal flowrate for flight condition).
   c. Totalizer fuel drop versus fuel flowmeters.
      If no discrepancy is noted, continue mission. If any portion of this check reveals a loss of fuel, consult "Excessive Fuel Depletion Procedure," this section.

EXCESSIVE FUEL DEPLETION PROCEDURE.

Some fuel system failures can result in fuel depletion rates that are capable of exhausting the entire aircraft fuel supply in minutes. It is highly recommended that the following steps be accomplished without delay while enroute to the nearest suitable airfield. If an excessive fuel depletion rate is known or suspected proceed as follows:

WARNING

- Due to the fire hazard from fuel impinging on the fuselage, afterburner thrust will not be used during or following an excessive fuel depletion, or sooner than one minute after completing air refueling operations, unless the additional thrust is necessary to sustain flight.
- Following an excessive fuel depletion in flight, the speed brake should be extended momentarily and retracted, followed by weapons bay doors opened momentarily then closed to ventilate these areas of fuel and vapors.

1. Throttles—Set minimum power practical.
2. Fuel transfer knob—OFF.
   Terminate all transfer from weapon bay, external and wing tanks. If this stops the excessive fuel depletion, the leak/failure was in a transfer line. Normal fuel procedures may be used, however fuel should be transferred from weapon bay, external and wing tanks only if necessary to reach a suitable airfield.

Note

To avoid unnecessary loss of fuel do not allow transfer system to operate with fuselage tanks full. If transfer is necessary, allow total fuselage fuel to deplete to approximately a 20,000 pound maximum and select the desired tank(s) manually (Do not use AUTO transfer).

3. Fuel flowmeters—Checked.
   Determine if either fuel flow is excessive by comparing:
   a. Flowmeters with each other and against normal flow rate for flight condition.
   b. Engine instruments versus throttle position.
   c. Engine response to throttle movement.
   If neither fuel flow is considered excessive, proceed to step 4. If either fuel flow is excessive, proceed as follows:

d. Throttle of affected engine—OFF.
e. Fire pushbutton—Depress.
f. Land as soon as possible.

If An Excessive Fuel Depletion Rate Exists:

4. Altitude—Checked.
   Gravity feed with fuel tanks unpressurized may be accomplished at any altitude below 30,000 feet provided the throttles are set at MIL power or below.
5. Engine feed selector knob—OFF.
6. Tank pressurization switch—OFF.
7. Fuel tank depletion rate—Checked.
   If the excessive depletion rate is reduced or stopped, maintain gravity feed except for periodic use of AUTO engine feed to establish proper fuel differential between the forward and aft tanks. If the use of AUTO fails to obtain proper fuel distribution, refer to "Landing With Abnormal Fuel Distribution," this section.

ABNORMAL FUEL DISTRIBUTION/INDICATION.

Suspected Fuel Quantity Indicator(s) Malfunction.

Continued operation with a fuselage fuel quantity indicator malfunction and with the engine feed selector knob in the AUTO position may result in a fuel imbalance and a shift in center-of-gravity. Manual fuel management is necessary to keep the desired 8200 lb. fuel differential between the forward and aft fuselage tank.

1. Engine feed selector knob—AFT.
2. Fuel quantity indicators—Test.
   Check forward, aft, and total fuel quantity indications:
   a. If an indicator fails to test, it should be considered inoperative. Monitor the other two indications to determine the fuel distribution and operate fuel system manually to maintain at least 8200 pound differential.

Note

If the total/select fuel quantity indicator is considered inoperative, but both the forward and aft tank indicator pointers operate normally, auto feed may be continued.

   b. If more than one fuel quantity indicator fails to test, remain on aft tank feed and burn the aft tank empty. Select forward tank feed when the aft tank pump lamps light and reduce forward tank fuel quantity to below 8000 pounds prior to landing.

If Aft Tank Is Not Feeding:

3. Do not dump fuel.

If Elevator Position Is More Than 1 Degree Down:

4. Wing sweep—Aft until 1 degree or less is obtained.

WARNING

- If the aft tank is not feeding, an aft center-of-gravity problem may result from continued flight. Land as soon as possible. Do not dump fuel. Jettison external stores if necessary to reduce gross weight.
- If the elevator position is more than 1 degree down position wings aft until one degree or less is obtained.

Note

For aircraft with inoperative surface position indicators, a wing sweep of 40 degrees will provide adequate safety margin for the most adverse fuel distribution that can be encountered with no external stores.

5. External stores—Jettison. (If required)
6. Land as soon as possible. (Refer to "Landing With Aft Abnormal Fuel Distribution," this section).

Forward Abnormal Distribution.

Crosscheck elevator position and fuel quantity indicators. After confirming an abnormal forward distribution, select FWD engine feed until desired distribution is obtained. Dump can be utilized if required. Refer to "Landing With Forward Abnormal Fuel Distribution," this section.

GENERATOR FAILURES.

SINGLE GENERATOR FAILURE.

Failure of one generator will be noted by the lighting of the applicable caution lamp. One generator in normal operation is sufficient to support the entire electrical load or demand. Should generator caution lamp light proceed as follows:

Note

The flight control system computers operate on 115 volt ac power from the essential ac bus. The essential ac bus is in-turn normally fed by the left generator. An interruption of power to the essential ac bus, such as loss or shutting down of the left generator or switching from left generator to external power will cause a mild shifting of the flight controls. This may also be accompanied by stick movement. Usually this will be felt as a mild air frame disturbance and should not be cause for concern.

1. Electrical control panel—Check.
   Check electrical control panel for proper position of switches and that the power flow indicator reads TIE.

If Power Flow Indicator Reads TIE Or The Generator Caution Lamp Is Lighted:

2. Emergency generator switch—As required.
   The emergency generator switch should be left in AUTO to prevent a drain on the hydraulic system when flight is being conducted under visual flight conditions. Emergency electrical power will be available within one second if the other primary generator fails. Position the switch ON during instrument flight and prior to descent for night landings.

WARNING

Failure of the ac sensing relay will connect the emergency generator to the essential bus when ON is selected. This failure will be indicated if the flow indicator reads EMER when emergency generator switch is placed to ON, and an engine driven generator is still operative.

Note

If the emergency generator lamp does not light, when the emergency generator switch is placed to ON, depress the emergency generator indicator/cutoff button. If the lamp still does not light, and the bulb is good, the emergency generator is inoperative and there is no back-up for the operative engine driven generator.

If emergency generator switch is placed to ON and power flow indicator reads EMER, accomplish the following prior to attempting to reset the generator.

a. Emergency generator indicator/cutoff pushbutton—Pulled.
b. Battery switch—OFF. (Leave OFF for remainder of flight)
c. Emergency generator switch—AUTO.
d. Emergency generator indicator/cutoff pushbutton—In.

3. Pitch damper switch—OFF. (Within dampers off region)
   Adjust flight envelope, as necessary, to dampers off region and place pitch damper switch OFF until the malfunctioning generator can be restored to normal operation or until all attempts to reset the generator are completed. Turning the pitch damper OFF will prevent possible flight control transient commands, through the pitch damper, resulting from electrical power surges, during attempts to reset generators.
4. Applicable generator switch—OFF-RESET, START (pause), then release to RUN.
   Place the generator switch to OFF-RESET then hold to START, pause approximately one second and release the switch to RUN. (Attempts to reset generator may be repeated if desired)

If Power Flow Indicator Reads NORM And The Generator Caution Lamp Is Out:

5. Emergency generator switch—AUTO.
6. Pitch damper switch—DAMPER.

If Power Flow Indicator Reads TIE:

7. Generator switch—OFF-RESET.
8. Decouple pushbutton—Depress.
9. Pitch damper switch—DAMPER.

DOUBLE GENERATOR FAILURE WITH BOTH ENGINES OPERATING.

Double generator failure will not result in a total loss of electrical power for more than the maximum of one second required for the emergency generator to provide power for the essential ac and dc buses. During operation on emergency generator power the airspeed mach indicator, the altitude vertical velocity indicator, the angle-of-attack tape and indexers (prior to T.O. 1F-111-891) will be inoperative. Yaw and roll trim will be inoperative.

Refer to Section I for list of equipment that is powered by the essential buses.

WARNING

- Prior to T.O. 1F-111-755, if the pitch damper has been turned OFF prior to loss of power, the switch will return to DAMPER prior to the emergency generator coming on the line.
- Power interruption will cause the auxiliary flight reference system (AFRS) gyros to revert to automatic fast erection. This will be indicated by the auxiliary attitude (AUX ATT) caution lamp lighting, the OFF flag on the standby attitude indicator, and the ADI.
- The angle-of-attack indicator will be inoperative when operating on emergency generator power even though angle-of-attack indications appear normal. The angle-of-attack indexers, however, will be operative. (After T.O. 1F-111-891).

1. Emergency generator switch—ON.
2. Electrical control panel—Check.
   Check electrical control panel for proper position of switches and that the power flow indicator reads EMER.
3. Maintain one "g" flight.

WARNING

To assure adequate hydraulic pressure for emergency generator operation, do not open speedbrake. Maintain a minimum of 90 percent rpm on both engines while closing speedbrake, if it is open, and for wing sweep and landing gear operation.

4. Pitch damper switch—OFF. (Within dampers off region)
   Adjust flight envelope as necessary, to damper off region, and place pitch damper switch OFF until the malfunctioning generator can be restored to normal operation or until all attempts to reset the generator are completed. Turning the pitch damper OFF will prevent possible flight control transient commands through the pitch damper resulting from electrical power surges.
5. Generator switches (individually)—OFF-RESET, START (pause), then release to RUN.
   Individually place the generator switches to OFF-RESET then to START, pause approximately one second and release switches to RUN.
6. Pitch damper switch—DAMPER.
   For continued operation with one or both engine driven generators or the emergency generator supplying power, place the pitch damper switch to DAMPER.

If Power Flow Indicator Reads EMER:

7. Fuel panel—Check.
   With only the emergency generator providing electrical power, only fuel boost pumps 4 or 5 or transfer pumps 7 and 8 or 12 will be operable. Refer to "Fuel System Operation On Emergency Electrical Power," this section.
8. Land as soon as practicable. (Refer to "Fuel System Operation On Emergency Electrical Power," this section.)

EMERGENCY GENERATOR OPERATION WITH ONE ENGINE SHUT DOWN.

In the event of a generator failure on the operating engine with the other engine shut down the following should be accomplished.

WARNING

The angle-of-attack indicator will be inoperative when operating on emergency generator power even though angle-of-attack indications appear normal. The angle-of-attack indexers, however, will be operative (aircraft after T.O. 1F-111-891).

1. Emergency generator switch—ON.
2. Establish and maintain nominal 1 "g" flight and an airspeed of 350 KIAS or less. Then, maintain a minimum of 90 percent rpm on the operating engine.
3. Do not open or close speedbrake.
4. Sweep wings forward to 26 degrees by moving the wing sweep handle at a smooth rate not to exceed 1 degree of sweep per second.

WARNING

Flight control damper transients may be experienced if hydraulic demands cause an interruption of the emergency generator power.

5. Land as soon as possible using "Single Engine Emergency Generator Landing" procedures, this section.

COMPLETE ELECTRICAL FAILURE.

In the event of complete loss of electrical power the aircraft will be flyable, but should be landed as soon as possible. The following are considerations to be applied as necessary. (1) Airspeed should be maintained within "damper off operating limits" as stability augmentation is not available. (2) Special attention should be given to setting wing sweep for landing to compensate for a possible aft CG condition as fuel is available from the forward tank (suction feed) only and the CG will shift aft as fuel is consumed. (3) If the wing sweep handle is moved to the 16° detent, the handle will lock at that position and the wing cannot be moved aft. The wing sweep position indicator will be inoperative. (4) Slats and flaps can be extended using normal extension procedures. Auxiliary flaps and the slat/flap position indicator are inoperative. (5) The landing gear must be extended using emergency extension procedures. No gear down indications will be available. (6) Utility lights only will be operational if battery power is available. (7) Standby A/S, ALT, and RPM will be operational; all other flight instruments are inoperative. (8) Estimate fuel consumption as closely as possible to aid in setting wing sweep for landing. (9) Radio communications may be attempted with the emergency radio contained in the quick rescue kit.

GLASS PANEL FAILURE OR UNLOCKED CANOPY INDICATION.

Loss of a glass panel, windshield, and/or canopy will not, of itself, cause the aircraft to become uncontrollable or unstable. However, such a failure may result in conditions whereby one or both crew members may be incapacitated and aircraft control degraded. Conditions that can be expected to occur instantaneously

include severe wind blast, unbearable noise levels, loss of intercom and radio communications, limited visibility and possible personal injury, and/or aircraft damage due to flying debris. Should windshield/glass panel failure occur, the first aircrew reaction should be directed at maintaining control of the aircraft. Either crew member that is capable of maintaining control should take control of the aircraft, level the wings, reduce airspeed as required, and climb/descend to a safe flight level. If aircraft control cannot be achieved or maintained, initiate ejection procedures. If time and conditions permit, the following actions should be taken.

1. Visors—Down.
2. Oxygen mask and fitting—On, 100 percent.
3. Canopy latch handle—Check locked.
4. Obtain a safe altitude and airspeed.
5. Pressurization selector switch—COMBAT.
6. Land as soon as practicable.

HYDRAULIC SYSTEM FAILURE.

PRIMARY OR UTILITY HYDRAULIC SYSTEM FAILURE.

Failure of either hydraulic system will cause the pitch, roll, and yaw damper caution lamps and the hydraulic low pressure caution lamps to light. The damper servo-actuators will operate as non-redundant servos. As the hydraulic pressure drops and the damper caution lamps light, forces may be felt in the control stick. Loss of either hydraulic system will result in the loss of automatic control and normal operation of all hydraulically operated components except flight controls and wing sweep. The emergency generator, nosewheel steering, and speed brake will be completely inoperative. Back-up systems are provided to operate the spikes, landing gear extension, flaps and slats, wheel brakes, air refueling system and weapons bay doors.

1. Wing sweep handle—26 degrees.

   Maintain wing sweep position compatible with airspeed and sweep wings to 26 degrees when at appropriate airspeed. Minimize flight control movement during wing sweep.

CAUTION

Maintain nominal 1 "g" flight while changing wing position. Change wing sweep position by moving the wing sweep handle at a smooth rate not to exceed 1 degree of sweep per second to avoid depleting hydraulic pressure.

Note

If supersonic and wings are aft of 50 degrees, retard throttles and sweep wings forward slowly to 50 degrees to enhance deceleration. When reaching subsonic speeds sweep wings forward slowly to 26 degrees.

2. Maintain airspeed within the damper off operating limits.
3. Depress the damper reset button only if the affected system pressure returns to normal.
4. Land as soon as possible using "Primary Or Utility Hydraulic System Failure Landing," this section.

COMPLETE HYDRAULIC SYSTEM FAILURE.

1. Eject.

WARNING

If both hydraulic systems fail during flight, the flight control system will be inoperative and flight cannot be continued.

OIL SYSTEM MALFUNCTIONS.

An oil system malfunction on either engine is recognized by a change in oil pressure, a complete loss of oil pressure, or excessive oil temperature. In general, it is advisable to shut down the engine as soon as possible after a drop in oil pressure is indicated, to minimize the possibility of damage to the engine. However, if thrust is critical, the engine may be utilized as long as it continues to produce power.

OIL PRESSURE BELOW 30 PSI.

1. Throttle of affected engine—OFF. (If flight conditions permit)

CAUTION

If oil pressure goes to below 30 psi and it is necessary to keep the engine operating to sustain flight, engine seizure can be expected.

OIL PRESSURE BETWEEN 30 AND 40 PSI. (EXCEPT AT IDLE)

1. Throttle of affected engine—IDLE.
2. Monitor oil pressure.

OIL PRESSURE ABOVE 50 PSI.

1. Throttle of affected engine—Retard.

   Reduce thrust on affected engine. If oil pressure can be maintained below 50 psi continue to operate engine at the reduced power setting. If oil pressure cannot be reduced below 50 psi, shut down the engine.

SPIKE SYSTEM FAILURE.

Since there is no positive means of determining spike position, a spike system failure or spike mispositioning can be recognized only by a reduction in engine or engine inlet performance. The evidence of a spike system failure will differ according to airspeed at the time of failure. Failure of the spike system will most probably be evidenced by inlet buzz and/or compressor stall.

1. Airspeed—Reduce until inlet buzz or compressor stall disappears.

SMOKE AND FUME ELIMINATION.

1. **OXYGEN—100 PERCENT.**
2. Air source selector knob—L. ENG, R. ENG.

   Attempt to determine if the engines are the source of smoke by selecting L. ENG and R. ENG positions. If source of smoke cannot be isolated to an engine, proceed to next step:
3. Air source selector knob—BOTH.

Attempt to isolate source of smoke or fumes as follows:

4. Non-essential electrical equipment—OFF.

Note

If condition still exists, do not accomplish step 5, proceed to step 6.

5. Electrical equipment—ON. (As required)

   Turn on electrical and lighting equipment one system at a time, and check for smoke until source is determined.
6. If smoke persists, position the air source selector knob to OFF.
7. If smoke or fumes persist, position the air source selector knob to RAM/EMER.

Note

- Moving the air source selector knob from OFF to RAM should be accomplished without pausing in the intermediate positions to prevent the possible introduction of more smoke from one or both of the engines.
- Selecting RAM position will open the ram air scoop, dump cabin pressure, and close the pressure regulating and shutoff valve.

SPEEDBRAKE MALFUNCTIONS.

Speedbrake Fails To Retract:

1. Speedbrake hydraulic valve circuit breaker—Pull out.
2. Before extending gear—Push circuit breaker in.

OUT-OF-CONTROL RECOVERY PROCEDURES.

Detailed out-of-control characteristics are described in Section VI under "Stall/Loss of Control Characteristics." In general, stalls, post stall gyrations and spins are the result of exceeding the angle-of-attack limits in Section V and recovery is achieved by reducing angle-of-attack to within limits.

WARNING

Near the angle-of-attack limits, induced drag increases rapidly and may cause the total drag to exceed the total thrust available. This results in rapid airspeed decrease and/or increase in sink rate. The resulting increase in angle-of-attack may be sufficient to cause overshoot of the angle-of-attack limits and subsequent departure from controlled flight.

Conventional aerodynamic stall warning such as a sudden "g" break, stick force changes or other pronounced cues are not available to warn the pilot of impending departure from controlled flight. The departure will occur as a smooth but uncommanded yawing and rolling motion. Unless the pilot monitors angle of attack and observes artificial stall warning, aircraft control may be lost.

WARNING

The command augmentation feature of the flight control system will attempt to maintain the stick-command level of pitch rate, "g" force, and roll rate independent of airspeed variations. For instance, during flight conditions where airspeed is decreasing, the horizontal stabilizer will be commanded to increase angle-of-attack, without additional pilot input, in an attempt to maintain the commanded level of pitch rate, roll rate, and "g" force. Failure to monitor and control angle-of-attack within limits can result in inadvertent rapid departure from controlled flight.

1. **STICK—FULL FORWARD AND CENTERED.**
2. **RUDDER—NEUTRAL.**
3. **ROLL DAMPER—OFF.**

WARNING

Action of the roll damper after departure can delay recovery of aircraft control.

4. Throttles—As required.

Note

If in afterburner, reduce power to MIL. If below afterburner range, do not reposition throttles. To do so may result in engine stalls.

WARNING

- Hold recovery controls until all significant angular motions have damped, the nose is well below the horizon, airspeed is above 200 KIAS and increasing, and angle-of-attack is below 15 degrees and decreasing. Care must be taken to assure that airspeed is increasing and angle-of-attack is decreasing. Erroneous values may be occasionally presented on the angle of attack indicator when the aircraft angle-of-attack is above the indicator limit (25 degrees).
- Engine stall and resulting loss of hydraulic power may occur in an out-of-control condition. To conserve hydraulic power, do not change aircraft configuration (flaps, wing sweep, etc.). If engine rpm drops below 35 percent on both engines, hydraulic power many be insufficient for recovery.
- During recovery from out-of-control conditions, it may be necessary to obtain an air speed of as much as 300 KIAS to recover a stalled engine.
- High descent rates (up to 20,000 feet per minute) may exist during out-of-control maneuvers.
- If aircraft control has not been recovered at an altitude of 15,000 feet above the terrain —Eject.

If Recovery Is Effected:

5. Roll damper—DAMPER.

SPIN RECOVERY PROCEDURE.

If the out-of-control recovery procedure has not produced a recovery, the aircraft is probably spinning. A spin is indicated by an angle of attack above stall angle of attack (indicator generally at 25 or minus 2 to 3 degrees), low airspeed (140 KIAS or lower), and turn needle fully displaced in the direction of spin rotation.

If these conditions are confirmed, perform the following recovery steps:

1. Stick—Forward and full with turn needle. (Pitch and roll control centered, if inverted)

WARNING

- Both full lateral control and forward stick are required to effect spin recovery. In order to obtain full lateral control deflection, less than full forward stick will have to be held.
- Jettisoning of external stores can result in store/aircraft collision.

2. Rudder authority switch—FULL.
3. Rudder—Full opposite turn needle.

When Aircraft Rotation Stops:

4. Stick—Forward and centered. (Pitch and roll control centered, if inverted)
5. Rudder—Neutral.
6. Roll damper—DAMPER.

WARNING

- Immediately after rotation stops, the aircraft will unload and negative "G's" may be encountered. This unloading is to be expected during recovery and can be moderated by reducing forward stick deflection. Longitudinal oscillations may continue for several cycles after the aircraft unloads and no attempt should be made to counter these oscillations. During the recovery process, the aircraft will be in a near vertical attitude and external visual cues may be confusing. Continual monitoring of airspeed, angle-of-attack, and altitude is mandatory. Hold recovery controls until the angle-of-attack remains below 15 degrees and airspeed continues to increase. During this period, residual pitch oscillations and a slow roll may exist even though the aircraft has recovered and is flyable. The aircraft pitch response will track with the control stick when the aircraft is positively under control. If positive control has not been attained by 15,000 feet above the ground, eject.
- Do not exceed 15 degrees angle-of-attack during recovery.

- During recovery from either a poststall gyration or spin, the aircraft may occasionally encounter a series of uncommanded, rapid rolls near or below the angle of attack limit due to inertia coupling. These rolls may demonstrate roll rates as high as 180 degrees per second, even though roll control is centered. The key to recognizing this situation is building airspeed above 200 KIAS and an angle-of-attack below stall. If maintaining full forward stick does not produce a rapid reduction of this high roll rate condition, neutralize all controls, and roll rate should begin to decrease immediately. Although uncommanded rolling will continue for 1 to 2 turns, recovery should be complete in 5 to 10 seconds. If uncommanded roll rate has not subsided within 5 to 10 seconds, rudder should be applied opposite the roll direction. As the roll rate slows near zero, ease the stick forward to further reduce angle of attack and neutralize rudder.
- If lateral control with the spin direction is maintained even though the yaw rotation has stopped and angle-of-attack has reduced to a value below stall, the aircraft will begin to roll because of the lateral command and building airspeed. The pilot may mistake this rolling motion as a continuation of the spin and incorrectly continue to hold in full aileron. The key to recognizing when to neutralize the controls is a building airspeed above 200 KIAS and an angle-of-attack well below stall. Failure to neutralize roll and yaw controls will result in an excessive altitude loss after the initial out-of-control condition has been corrected.

7. Throttles—As required.
8. Air start button—Depress.
9. After controlled flight and normal engine operation is restored, the wings, if aft of 45 degrees, should be swept forward to minimize altitude loss and excessive speed buildup.
10. If still out of control by 15,000 feet above ground level—Eject.

THROTTLE MALFUNCTIONS.

EXCESSIVE THROTTLE FRICTION.

When high throttle friction or unsteady (jerky) throttle movement is encountered, an impending throttle binding problem may be indicated. If this condition occurs, move the affected throttle to maintain approximately 80 percent rpm and use the other throttle to control airspeed.

FROZEN THROTTLE IN AFTERBURNER RANGE.

1. Relax force on throttle for 20-30 seconds.
2. Attempt slight throttle advance; then apply force to retard throttle to 80 percent rpm.

ENGINE SHUTDOWN WITH A FROZEN THROTTLE.

1. Engine fire pushbutton—Depress.

Note

- Engine may be shut down from any power setting.
- If engine is shut down in flight with the fire pushbutton, refer to "Single Engine Landing" and "Go-Around," this section.
- If throttle is frozen above the IDLE position, ground roll spoilers will not be available on landing roll.

WHEEL WELL OVERHEAT DURING FLIGHT.

The most probable cause of a wheel well overheat condition would be a ruptured engine bleed air duct. The detection system will indicate a hot condition and light the wheel well hot caution lamp. After T.O. 1F-111-946, the lamp will also light when an overheat condition is detected in the weapons bay routing tunnel or a-c power panel area. A fire condition may exist, and as it progresses will probably be verified by loss or degradation of the hydraulic and electrical systems and/or a smoke trail. Note that the corrective crew action includes shutting off the engine bleed air source; therefore, equipment cooling and cabin pressure will not be available. Airspeed should be reduced to achieve favorable conditions for emergency ram air cooling and no cabin pressure. After the hot light goes out, a visual inspection should be made of the wheel well and surrounding area (by chase aircraft or tower fly-by) and the aircraft should be landed as soon as practicable. If the wheel well hot caution lamp lights, proceed as follows:

1. Air source selector knob—OFF or EMER. (As applicable)

   For supersonic flight with high total temperature indications, place the selector knob to OFF and decelerate and descend to decrease total temperature indication and establish an altitude where cabin pressure is not required. If total temperature and/or altitude is not a consideration, place the knob to EMER and descend as outlined above. (Refer to "Ram or Emer Mode Flight Limits," Section V.)

   Note

   Placing the air source selector knob to OFF shuts off engine bleed air but does not dump cabin pressure. The EMER position of the knob shuts off bleed air, opens the ram air scoop and dumps cabin pressure. With high total temperature indications, opening the ram air scoop will result in excessive cabin temperature.

2. If lamp does not go out 10 seconds after placing the air source selector knob to OFF or EMER, open the speed brake door and when airspeed permits, extend the landing gear.
3. Land as soon as practicable.

LANDING EMERGENCIES

APPROACH END BARRIER ENGAGEMENT.

Approach end arrestments are considered practicable and should be attempted when directional control and stopping distance are questionable or when a malfunction presents a threat to directional control and there is sufficient runway in front of the barrier on which to land and lower the nose wheel prior to barrier contact. Consideration should also be given to the engaging speed limits to prevent structural failure of the arresting barrier or the aircraft.

Note

Fly a straight-in approach when possible to insure an accurate touchdown point on the runway. Considerations should also be given to actions taken if engagement is missed; go-around and barrier engagement on the other end of the runway.

1. Reduce gross weight.
   Time permitting, dump and/or burn fuel to reduce gross weight as low as practicable.
2. Normal Procedures Checklists—Complete.
3. Throttle friction—Reasonably tight.
   Deceleration forces could cause throttles to be thrown forward if not tight.
4. Arresting hook—Extend, check hook lamp lighted.
   If time permits, extend hook where cover may be recovered and will not cause injury to persons on the ground.
5. Shoulder harness—Locked.
6. Touch down in center of runway at least 400 feet short of cable without landing flare.
7. Lower nose immediately.
   Do not make an attempt to steer aircraft to center of barrier. Off center engagement may cause the aircraft to veer off course to the off-center side of the runway. Barrier contact should be made with nosewheel steering disengaged. No attempt to correct yaw or roll tendencies during the arrestment should be made until the aircraft is slowed sufficiently to insure aircraft control.
8. Throttles—IDLE.
   Reduce power to idle at touchdown to insure spoiler brake operation.
9. Engage barrier with brakes off.
   Roll back may occur depending on type of barrier used. Roll back will be parallel to runway center line for either on center or off center engagements. Light braking should be applied at the end of the arrestment when possible to minimize rollback without causing the aircraft to pitch up.
10. Keep engines running until crash crews arrive and signal for engine shutdown.
11. If emergency evacuation is required, pull the auxiliary/parking brake handle, shut down engines and abandon the aircraft.

WARNING

During emergency engine shutdown for evacuation some fuel will be dumped overboard in the proximity of the main wheel area and could cause a fire hazard.

BLOWN TIRE/FLAT MAIN STRUT LANDING.

If barrier engagement is to be made, refer to "Approach End Barrier Engagement," this section.

MAIN GEAR TIRE/STRUT.

1. Normal Procedures Checklists—Complete.
2. Fly a straight-in approach.
3. Anti-skid switch—ON.
4. Touch down on side of the runway opposite the blown tire/flat strut.
5. Lower nose and use nose wheel steering and differential braking as required to keep the aircraft on the runway. The brake on the good tire should be used normally. Do not lock the brake on the wheel with blown tire.

NOSE GEAR TIRE.

1. Normal Procedures Checklists—Complete.
2. Spoiler switch—OFF.
3. Fly a straight-in approach.
4. Delay lowering nose to runway until just prior to losing flight control effectiveness. Then, apply aft stick for aerodynamic braking effect but keep nose wheel on runway.
5. Use differential braking as required for directional control.

DAMPERS OFF LANDING.

If a landing is to be made with any or all of the dampers OFF proceed as follows:

1. Land using a straight-in approach.

2. Avoid large or abrupt control inputs.
Crosswind landings with the pitch or roll dampers inoperative require no special considerations or techniques other than observing those limitations specified under "Flight With Dampers Off," Section V. However, a crosswind landing with the yaw damper inoperative, especially under gusty wind conditions, requires special techniques and considerations. It is recommended that the pilot establish a crabbed drift correction on the final approach. Do not attempt to assume a wing-low drift correction during the transition and touchdown phase. Instead, maintain the required crab drift correction through touchdown, not to exceed 10 degrees yaw or crab angle. In addition, minimize yaw inputs or corrections on final approach, especially during the transition phase just prior to touchdown. Because the aircraft has low directional damping in this configuration, rudder inputs to correct for yaw variations resulting from gusts or lateral control inputs should be kept small to avoid yaw overshoot in the opposite direction.

DITCHING.

It is recommended that ejection be accomplished rather than ditching. If ditching is unavoidable, proceed as follows:

1. Fuel dump—As required.
2. Oxygen—100 percent.
3. Flaps/slats—Extended.
4. Landing gear—Retracted.
5. Approach at an angle-of-attack of 12 degrees as indicated on the angle-of-attack indicator.
6. Adjust power to maintain angle-of-attack of 12 degrees with minimum sink rate. (Not to exceed 200 feet per minute)
7. Hold constant angle-of-attack and do not flare the aircraft before touchdown.

Upon Water Contact:

8. Stick—Neutral.
9. Throttles—OFF.
10. Pull severance and flotation handle.

WARNING

Pulling the severance and flotation handle and the auxiliary flotation handle does not disable the rocket motor; it will still fire if either ejection handle is pulled. To preclude inadvertent firing of the rocket motor during the ditching sequence, both ejection handle safety pins must be installed.

Should crew module structure rupture or canopy transparency break during the course of ditching and severance, cabin flooding beyond the capability of the bilge pump may result. Proceed as follows:

11. Continue to wear oxygen mask.

Note

Emergency oxygen will be automatically supplied when the severance and flotation handle is actuated (manual actuation is also possible by means of the emergency oxygen handle).

12. Auxiliary flotation handle—PULL.

Note

Pulling the auxiliary flotation handle will cause even a flooded crew module to float with sufficient freeboard to open canopy hatches.

13. Insert safety pins into ejection handles.

WARNING

Pulling the severance and flotation handle and the auxiliary flotation handle will sever the module from the aircraft bypassing the rocket motor. The rocket will fire if the ejection handle is pulled or accidentally activated.

LANDING WITH ABNORMAL FUEL DISTRIBUTION.

The following paragraphs cover both "Landing With Aft and/or Forward Abnormal Fuel Distribution."

LANDING WITH AFT ABNORMAL FUEL DISTRIBUTION.

1. Between 250 and 300 KIAS, in stabilized flight with the slats and flaps retracted, check if the wings can be swept forward to 26 degrees and not exceed 1 degree down elevator. If the elevator position does not exceed 1 degree down, extend the slats and flaps and make a normal landing from a straight-in approach. After extending the flaps and slats and throughout the landing approach, insure the elevator position is 3 degrees or more trailing edge up. If at any time the average elevator position is less than 3 degrees trailing edge up, make a go-around (afterburner power should be avoided if at all possible to minimize the nose up pitching effect). Repeat the elevator position check with the flaps and slats retracted to determine the maximum allowable forward sweep for landing.

WARNING

- Do not sweep wings forward of 24 degrees in attempting to extend flaps.
- Do not make a landing approach with wings forward of 26 degrees.

- Do not make a landing approach with flaps/slats down and with average elevator positions less than 3 degrees up due to marginal stability.

Note

Landing should be made as soon as possible after the elevator position check since the center-of-gravity will shift as fuel is used.

2. If the wing cannot be swept to 26 degrees without causing elevator position to decrease below 1 degree down, utilize the wing sweep at which 1 degree down is obtained for landing and refer to "No Flap Landing," this section.

WARNING

Do not make a landing approach with average elevator positions greater than 1 degree down. Sufficient aircraft nose down elevator authority may not be available to maintain control of the aircraft.

LANDING WITH FORWARD ABNORMAL FUEL DISTRIBUTION.

1. Dump or burn all fuel until the aft tank is empty (fuel pump lamps on) and the elevator position indicator (EPI) indicates the cg is within limits for landing. If the EPI is inoperative, continue fuel dump/burn until the forward tank fuel level is decreased to reservoir tank only fuel remaining (fuel low lamp on). Refer to Section VI for landing wing sweep. Land as soon as possible.

LANDING WITH FLAP AND SLAT MALFUNCTIONS.

If conditions require landing with flap or slat malfunction, factors such as gross weight, approach speed, ground roll distance and runway condition must be considered. Diversion to a suitable alternate or approach end barrier engagement may be necessary. If flap position can be confirmed to be full up, landing should be made utilizing a "No Flap Landing," provided slats are symmetrical. If flaps can be confirmed to be full up but slats are asymmetrical, use a "Landing With Asymmetric Slat" procedure. If slats cannot be verified by gain changer lamps or visually to be approximately 70 percent down and flap position is confirmed or suspected to be other than full up, land using "No (Or Partial) Slats and Partial Flaps Landing," this section.

WARNING

- If flaps are confirmed or suspected to be other than full up and the slats cannot be verified by gain changer lamps or visually to be approximately 70 percent down, landing should be made utilizing "No (Or Partial) Slats and Partial Flaps Landing", this section.
- Flap position indicator is unreliable if malfunction is due to a slat/flap sequencing mechanism failure.

CAUTION

Placing the emergency flap/slat switch to the emergency position, relieves the hydraulic pressure to the flap motor and isolates the function of the flap handle and may prevent further damage.

FLAPS AND SLATS EMERGENCY EXTENSION.

1. Reduce airspeed to 180 KIAS or 10 degrees angle-of-attack, whichever is higher.
2. Flap/slat switch—EMER.
3. Emergency flap/slat switch—EXTEND and hold. (Emergency extension requires up to 60 seconds or more)

WARNING

- Prior to T.O. 1F-111-824, emergency flap extension with M-117 weapons installed on pylons 3 or 6 or fuel tanks installed on pylons 4 or 5 can result in interference if 34 degree extension is exceeded.
- Make a positive check that all slats are extended by visual observation of the slat position indicator and the slats themselves, prior to proceeding with flap extension. Flap extension without prior slat extension or with asymmetric slat extension can result in a mild to uncontrollable pitchup, stall, and rolloff depending on the magnitude of flap and slat deflections.

4. Flap/slat handle—DOWN.

Note

On aircraft 27 ♦, and those after T.O. 1F-111(B)A-569, the flap/slat handle provides electrical contacts at the 25 degree position to raise or lower auxiliary flaps.

LANDING WITH ASYMMETRIC SLAT.

1. Do not extend flaps.
2. Fuel dump—As required.

3. External stores—Jettison. (If required)
4. Normal Procedures Checklists—Complete.
5. Control system switch—T.O. & LAND. (Below 300 KIAS or mach 0.45, whichever is less).

WARNING

Attempting abrupt rolling maneuvers or bank angles in excess of 60 degrees with the flight control system switch in T.O. & LAND, can result in loss of control of the aircraft.

6. Fly long, shallow straight-in approach at 11 degrees angle-of-attack. (On final approach maintain ground track with rudder trim and lateral control)

WARNING

- Desired rate of descent should be established at beginning of approach and abrupt maneuvers, large throttle motions or flight in excess of 1 "g" should be avoided.
- Maintain an airspeed compatible with aircraft configuration and gross weight to insure that 10 degrees angle of attack is not exceeded during maneuvering flight prior to final approach phase.

Note

774-1 Maintain constant ground track by use of rudder trim and lateral control. Rudder trim up to full authority should be used to reduce lateral control requirements.

6A Elevator Position Indicator (EPI) Check

7. Landing:

WARNING

Aircraft will tend to veer in the direction of the extended slat upon touchdown if the lateral control is centered or the spoiler brakes extended. Lateral control, augmented with rudder as necessary, should be initiated upon touchdown to maintain desired ground track.

a. If ground roll distance is a consideration, utilize the short field landing procedure, Section II. Refer to figure 3-3 for approach speeds and landing roll distance.

8. Hook—As required.

WARNING

- If excessive braking is used at high speeds, the wheel blowout plugs may relieve tire pressure within 15 minutes after stop. Provisions should be made to cope with wheel fires which may start shortly after the blowout plugs relieve.
- Call the fire department after any emergency landing which results in hot wheels or brakes or use of the tail hook. Do not shut down the engines until after the fire trucks arrive. Fuel venting from the engines after shutdown may be ignited by the affected hot part.

NO FLAP LANDING.

Approaches with no flaps will necessitate a long, shallow, straight-in approach; refer to figure 3-4. (Approach speeds obtained from chart must be adjusted if carrying stores: Add 1 KIAS for each 1000 pounds in weapons bay; add 0.5 KIAS for each pylon station carrying weapons or tanks.) Approach angles-of-attack should be established by use of the angle-of-attack indicator on the AMI. Do not use the angle-of-attack indexer. For wing sweeps between 16 and 45 degrees, approach at 11 degrees angle-of-attack. For wing sweeps aft of 45 degrees, approach at 12 degrees angle-of-attack. Under these approach conditions, care should be exercised to avoid tail strikes at touchdown. Landings with wing sweeps greater than 45 degrees can be made with up to 20 knots of crosswind but roll response will be reduced to less than half due to spoiler lock-out. The stability augmentation system must be operating for crosswind landings with wing sweep greater than 45 degrees.

WARNING

- Desired rate of descent should be established at beginning of approach and abrupt maneuvers, large throttle motions or flight in excess of 1 "g" should be avoided. Any of the above can result in excessive sink rate build-up which may be difficult to arrest at approach altitudes.
- Maintain an airspeed compatible with aircraft configuration and gross weight to insure that 10 degrees angle-of-attack is not exceeded during maneuvering flight prior to final approach phase.

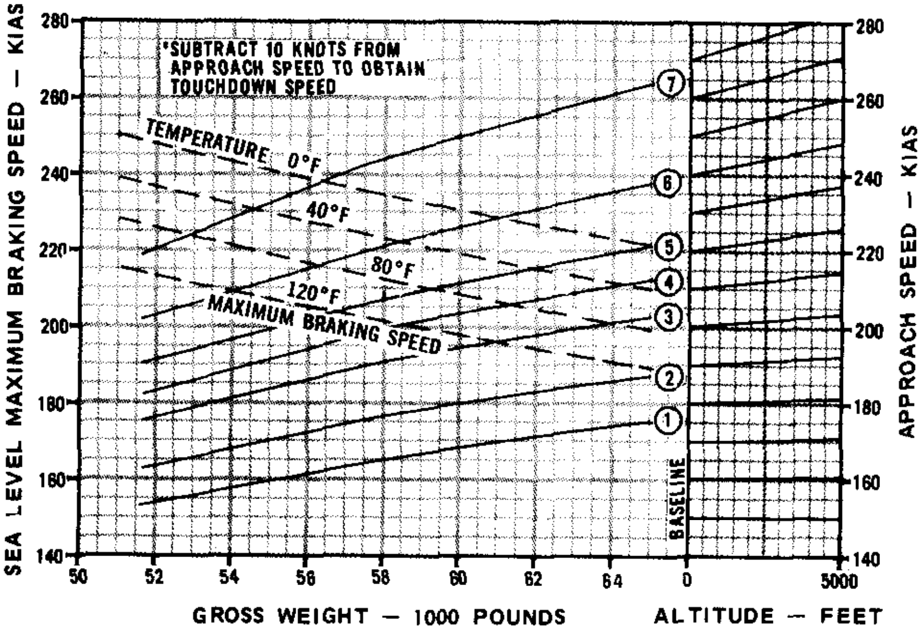
Emergency Landing Airspeeds and Minimum Ground Roll Distances

DATA BASIS: ESTIMATED
DATE: 29 DECEMBER 1972

CONFIGURATION:
- SLATS RETRACTED
- FLAPS RETRACTED
- NO EXTERNAL OR INTERNAL STORES

CONDITION:
- C.G. – NORMAL BURN
- MAXIMUM BACKSTICK DURING LANDING ROLL
- NO GROUND ROLL SPOILERS

FUEL GRADE: JP-4
ENGINES: TF-30-P-7

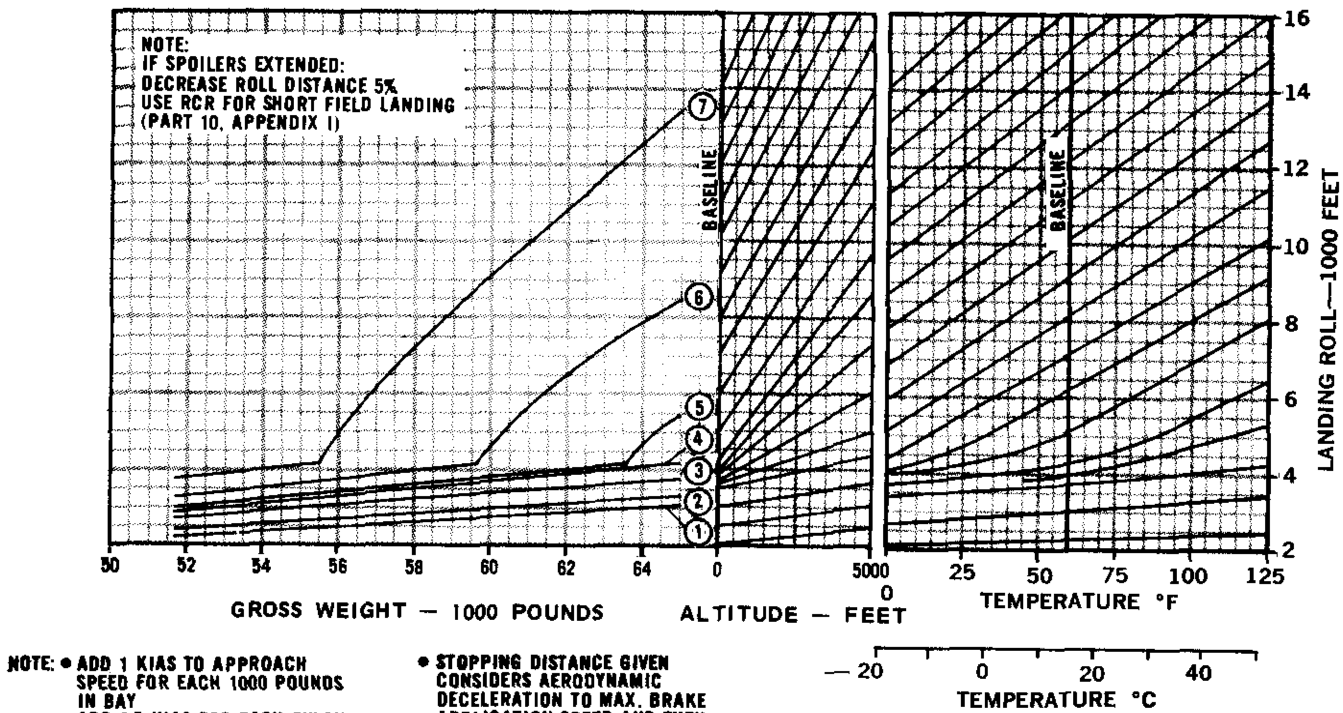


WINGSWEEP		INDICATED ANGLE OF ATTACK
①	16°	11°
②	26°	11°
③	35°	11°
④	40°	11°
⑤	50°	12°
⑥	60°	12°
⑦	72.5°	12°

NOTE:
- DECREASE MAXIMUM BRAKING SPEED BY 4.1 KNOTS/1000 FEET ALTITUDE

WARNING

REFER TO SECTION V FOR CENTER OF GRAVITY LIMITS AND BRAKE ENERGY LIMITS.



NOTE:
- ADD 1 KIAS TO APPROACH SPEED FOR EACH 1000 POUNDS IN BAY
- ADD 0.5 KIAS FOR EACH PYLON STATION WITH WEAPONS OR TANKS PRESENT.
- STOPPING DISTANCE GIVEN CONSIDERS AERODYNAMIC DECELERATION TO MAX. BRAKE APPLICATION SPEED AND THEN APPLICATION OF MAX. WHEEL BRAKES.

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Figure 3-3.

DATE: 19 MAY 1972

1. Fuel dump—As required.
   Because of the high approach and touchdown airspeeds required during landing with wings at 26 degrees or greater and no flaps, burn or dump as much fuel as practicable prior to entering traffic pattern.

WARNING

If landing is to be accomplished due to abnormal fuel distribution and fuel feed from aft tank cannot be confirmed, do not dump fuel.

2. External stores—Jettison. (If required)
3. Normal Procedures Checklists—Complete.
   a. *Compute emergency landing airspeed from figure 3-4.*
4. Flight control disconnect switch—OVRD. (When aft of 26 degrees wing sweep)
   Placing the flight control disconnect switch to OVRD deactivates adverse yaw compensation, auxiliary pitch trim, roll trim, TFR climb/dive commands, autopilot and pedal shaker.

Note

Once the flight control disconnect switch is placed to OVRD the pitch and roll gain changer lamps will remain on even though the control system switch is subsequently placed to T.O. & LAND, because AYC is not activated.

5. Control system switch—T.O. & LAND. (Below 300 KIAS or mach 0.45, whichever is less).

WARNING

74-1 Attempting abrupt rolling maneuvers or bank angles in excess of 60 degrees with the flight control system switch in T.O. & LAND, can result in loss of control of the aircraft.

5A Elevator Position Indicator (EPI)-Check

6. Landing:

Note

- Ground roll spoilers will not be available at wing sweep angles of 45 degrees or greater.
- If possible, sweep wings forward to obtain ground roll spoiler operation.

   a. If ground roll distance is a consideration, utilize the short field landing procedure, Section II. Refer to figure 3-3 for approach speeds and landing roll distance.

7. Hook—As required.

WARNING

If excessive braking is used, the wheel blowout plugs may blow out, relieving tire pressure within 15 minutes after stopping. Do not shut down the engines until the fire trucks arrive as fuel venting from the engines after shutdown may result in a fire.

NO (OR PARTIAL) SLATS AND PARTIAL FLAPS LANDING.

Landings with no (or partial) slats and partial flaps will require a long, shallow, and straight-in approach. Approach angle-of-attack should be 7 degrees and should be established by use of the angle-of-attack indicator on the airspeed mach indicator. Do not use the angle-of-attack indexer. Landing can be accomplished at 16 to 26 degrees wing sweep depending on center-of-gravity considerations. Approach speed will be greater than normal full flap landing speeds by approximately 20 percent at 16 degrees and 30 percent at 26 degrees, based on no slat extension and 15 degrees flaps extension. Speeds will vary with actual configuration, however, angle-of-attack is the primary speed reference for approach and landing. Figure 3-4 may be used to approximate ground roll distance.

WARNING

- Desired rate of descent should be established at the beginning of the approach and abrupt maneuvers, large throttle motions or flight in excess of 1 "g" should be avoided. Any of the above can result in excessive angle-of-attack build up (above 12 degrees) which could result in stall or uncontrolled roll off.
- Maintain an airspeed compatible with aircraft configuration and gross weight to insure that 7 degrees angle of attack is not exceeded during maneuvering flight prior to final approach.

1. Wing Sweep—Set as required.
   At 7 degrees angle-of-attack in stabilized flight, check the elevator position. If the elevator position is between 7 degrees up and 0 degrees, maintain the existing wing sweep. If the elevator position is greater than 7 degrees up, the wing should be swept forward or fuel dumped until the elevator position is between 7 degrees up and 0 degrees. If the elevator position is below 0 degrees, sweep wings aft (limit 26 degrees) until elevator position is between 0 and 7 degrees up. If elevator position is below 0 degrees with wing sweep at 26 degrees, refer to "Abnormal Fuel Distribution" this Section.

2. Fuel dump—As required.
   Fuel may be dumped as required to reduce landing speeds.
   Fuel should be dumped at 7 degrees angle-of-attack in stabilized flight and the elevator position monitored to assure that the elevator position is within the limits of step 1.
3. External stores jettison button—Depress. (If required)

Note

- Nuclear stores will not be jettisoned.
- Wing sweep may require readjustment after fuel is dumped or external stores jettisoned.

4. Normal Procedures Checklists—Complete.
   Wing sweep for landing is to be determined in accordance with step 1 of this procedure.
5. Control system switch—T.O. & LAND. (Below 300 KIAS or mach 0.45, whichever is less).

WARNING

Attempting abrupt rolling maneuvers or bank angles in excess of 60 degrees with the flight control system switch in T.O. & LAND, can result in loss of control of the aircraft.

6. Approach angle-of-attack—7 degrees.
7. Land as soon as practicable.

LANDING WITH ASYMMETRIC STORES.

If a large or heavy store asymmetry exists, landing can be accomplished using a 10 degree angle-of-attack approach. Landing configurations and approach speed should be established with sufficient altitude remaining to determine specific flying qualities prior to the final approach. A straight-in approach is recommended making full use of roll and rudder trim to establish an acceptable balance of lateral control force and angle of sideslip. As speed is decreased, the lateral trim required may exceed roll damper authority of ±6 degrees. Lateral control forces may be reduced through the use of rudder trim and/or by increasing final approach speed to obtain 8.5 degrees angle-of-attack. If a significant cross wind exists, land with the heavy wing up-wind if conditions permit. Using rudder to align the aircraft with the runway centerline may require full lateral control to hold the wings level. Do not exceed 360 feet per minute sink rate at touchdown. Normal braking technique may be used during the landing roll.

WARNING

As speed is decreased or load factors increased, the asymmetric effects become more pronounced.

HYDRAULIC SYSTEM FAILURE LANDING.

PRIMARY OR UTILITY HYDRAULIC FAILURE LANDING.

An approach end barrier engagement should be considered. Fly an extended downwind leg sufficiently long to provide time for lowering the landing gear and flaps by the emergency method. After touchdown, normal braking and anti-skid will be available until the brake accumulator pressure has been reduced to approximately 1100 psi (after approximately 10-14 full brake applications). Brake pedals will move to the fully deflected position as the accumulators deplete. To minimize consumption of brake accumulator hydraulic fluid, braking should be accomplished with as few brake applications as possible. A single moderate and steady brake application should be applied at the lowest speed practical to stop on the available runway. If the accumulator pressure has been reduced to less than 1100 psi, normal braking will not be available. If the barrier cannot be engaged, it will be necessary to pull the auxiliary brake handle to stop the aircraft. Only one set of spoilers will be available. If the runway is wet or icy, application of brakes at high speeds would result in anti-skid cycling, and depletion of the hydraulic accumulators, thereby losing the use of normal brakes for directional control and stopping. Dampers will not reset unless pressure returns to normal.

1. Anti-skid switch—OFF.
2. Spike control switches—OVERRIDE (below 0.9 mach).
3. Wing sweep—Adjust slowly for landing. (1 degree per second)
4. Emergency extension of flaps and slats.
5. Emergency extension of landing gear.
6. Normal Procedures Checklists—Complete.
7. Utilize aerodynamic braking and maintain directional control with the rudder as long as effective.
8. Hook—Extend. (If required)
9. Auxiliary brake handle—Pull. (If required)

CAUTION

Pulling the auxiliary brake handle while the aircraft is moving may cause the wheels to lock if normal brake accumulator pressure is available, and result in tire skidding or blowout, and may result in fire.

LANDING GEAR MALFUNCTIONS.

LANDING AFTER NOSE LANDING GEAR RETRACTION FAILURE.

Failure of the nose landing gear to achieve a proper up and locked indication after landing gear UP selection may be caused by malsequence between the nose gear and uplock mechanism. Such malsequence can

result in damage to the nose wheel steering linkage. To avoid directional control difficulty during the landing rollout after nose landing gear retraction failure has been confirmed:

1. Landing gear handle—DN.

Note

Do not recycle gear handle.

2. Landing gear emergency release handle—Pull.
   This will remove all hydraulic pressure to the nose steering system and will allow the nose gear to align with the runway.
3. Consider barrier engagement.
   Refer to "Approach End Barrier Engagement," this section.

UNSAFE GEAR INDICATION.

Landing gear unsafe (not down and locked) is indicated by either or both green landing gear position indicating lamps not being lighted after gear down selection. However, failure of one or both landing gear position indicator lamps to light, together with failure of the landing gear handle warning lamp to light after the gear has been lowered, indicates a probable malfunction of the gear position indicator lamp system. If the landing gear handle warning lamp remains lighted with nose and main gear down and locked, refer to "Landing Gear Handle Warning Lamp Lighted," this section.

Note

Each of the following steps will overcome a particular malfunction and should be followed in sequence.

1. *Malfunction and indicator lamps*—Checked.
2. Circuit breakers in—Checked.
   - Landing gear control
   - Landing gear warning
   - Speedbrake hydraulic valve
3. Utility hydraulic isolation switch—PRESSURIZE.
4. Obtain visual gear check, if main and nose gear appear to be properly extended, refer to "Landing With Unsafe Gear Indication," this section.

If Either Nose Or Main Gear Is Not Extended, Or *Visual Check Was Not Possible:*

5. Landing gear handle—Recycle.
   - Alternately impose a negative 1.5 "g" and a positive 2.0 "g" load on the aircraft and check for gear down indication.

CAUTION

Do not exceed 2.0 positive "g" during gear extension attempts.

6. If unable to obtain safe gear indication, refer to "Landing Gear Emergency Extension," this section.

LANDING GEAR HANDLE WARNING LAMP LIGHTED.

If the landing gear handle warning lamp is lighted, with nose and main gear down and locked, the speedbrake may be mis-positioned.

1. Speedbrake hydraulic valve circuit breaker—Pull.
   If proper speed brake position cannot be verfied visually:
2. Landing gear emergency release handle—Pull.
   If proper speed brake position/indication is not achieved:
3. Landing gear emergency release handle—In.

Note

After the landing gear emergency release handle is pulled, nose wheel steering will be inoperative and the nose wheels will be cocked approximately 40 degrees to the right. During landing roll the nose wheels will align and present no directional control problems. If the landing gear emergency release handle has been pushed in, reduced airloads during the landing roll may allow the speed brake to extend and drag the runway.

LANDING GEAR EMERGENCY EXTENSION.

1. Reduce speed to 160 KIAS or normal approach speed, whichever is higher. Using flaps and slats (as required).
2. *Landing gear handle*—UP. (DN *if main gear is* down and locked and speed brake is in trail.)
3. Landing gear emergency release handle—Pull.

WARNING

If the landing gear door/main landing gear partially extends and stops before full extension, do not push the landing gear emergency release handle back in. To do so will deplete the pneumatic pressure and reduce the possibility of completing gear extension. Leave the handle pulled out and check for positive down and locked indication. Time required to obtain this indication may exceed 10 minutes.

4. Landing gear handle—DN.
5. Landing gear position indicator lamps—Check.

If The Landing Gear Handle Warning Lamp Remains Lighted With Gear Down And Locked:

6. Landing gear emergency release handle—In.

CAUTION

If the landing gear emergency release handle has been pushed in, reduced airloads during the landing roll may allow the speed brake to extend and drag the runway.

Note

After the landing gear emergency release handle is pulled, nose wheel steering will be inoperative and the nose wheels will be cocked approximately 40 degrees to the right. During landing roll the nose wheels will align and present no directional control problem.

7. If landing gear is still unsafe, refer to "Landing With Unsafe Gear Indication," this section.

LANDING WITH UNSAFE GEAR INDICATION.

1. Perform landing gear emergency extension procedure (if required).
2. Consider barrier engagement.
   (Refer to "Approach End Barrier Engagement," this section)

If Approach End Barrier Engagement Is Not Used:

3. Fuel dump—As required.
4. External load—Jettison. (If required)
5. Normal Procedures Checklists—Complete.
6. Battery switch—OFF.
7. Shoulder harness—Locked.

If Nose Gear Is Unsafe:

8. Ground roll spoiler switch—OFF.
9. Fly normal pattern and landing.
   Stop aircraft on the runway and insert landing gear ground safety pins.

Note

Touch down at normal landing attitude; do not try to hold the aircraft off the runway. If spoilers are turned off, aerodynamic braking may be obtained by holding the nose off the runway. Light braking may be used in conjunction with aerodynamic braking. Lower the nose gently to the runway while sufficient longitudinal control is still available.

If Nose Or Main Gear Collapses:

10. Throttles—OFF. (After nose is on the runway)
11. Fire pushbuttons—Depress.
12. Abandon the aircraft as soon as possible.

LANDING WITH NOSE/MAIN GEAR RETRACTED.

Approach end barrier engagement with nose, main or both gear retracted is recommended but must take into consideration the barrier availability and type, runway, weather, and aircraft conditions. For all gear retracted landings the ground roll spoiler brake switch should be off. Consideration must be given to missed barrier procedures based on the nature of the gear problem. After the aircraft has engaged the barrier for an arrested landing or after speed has been reduced so that aerodynamic control is not effective, the engines should be shut off by use of fire pushbuttons as this will shut off hydraulic and fuel lines and lessen chance for fire from fuel drainage or hydraulic fluid leakage. Place the throttles to OFF after the fire pushbuttons are depressed to keep the engines from running on residual fuel downstream of the shutoff valve. If time is available, foam the runway 3000 to 4000 feet starting at the barrier to reduce fire hazard.

For Nose, Main Or Both Gear Retracted:

Fly a straight-in normal landing pattern with final approach at minimum sink rate.

1. Fuel dump—As required.
2. Normal Procedure Checklist(s)—Complete.
3. Ground roll spoiler switch—OFF.
4. Battery—OFF.
5. All nonessential equipment—OFF.
   This should include engine feed selector, fuel tank pressurization and fuel transfer switches.
6. Hook—Down. (If barrier engagement planned).
7. Shoulder harness—Lock.
8. Throttle friction—Reasonably tight.

Nose Gear Retracted:

For barrier engagement, touch down in center of runway, 400 to 600 ft. short of the cable. Prior to engagement, lower nose to a level attitude. Do not apply brakes. Immediately after cable engagement lower nose smoothly to runway. If a barrier engagement procedure is not utilized, lower the nose to the runway while control effectivenss still exists, and apply maximum braking.

Main/Both Gear Retracted:

For barrier engagement, touch down in center of runway so that hook makes contact just short of barrier cable. If a barrier engagement procedure is not utilized, maintain directional control with rudder.

9. Fire pushbutton—Depress.
10. Throttles—OFF.
11. Abandon aircraft.

SINGLE ENGINE LANDING.

During single engine operation, utility and primary hydraulic system flow is reduced by almost 50 percent. Aircraft response to normal control inputs will

not be adversely affected unless other hydraulic demands such as landing gear speed brake or wing sweep, etc. are being simultaneously utilized. Since the flight controls use both utility and primary hydraulic pressure the wings should be swept only in 1 "g" flight, and at reduced rate of 1 degree per second. Fuel should be dumped down to a minimum to reduce approach speed and gross weight. A long, moderately shallow straight-in approach should be flown with flaps set at 25 degrees. This is the optimum flap setting in case of a go-around. Maintain 8.5 degrees angle-of-attack until landing is assured. When landing is assured, increase angle-of-attack slowly to "on-speed." Operate engine as high as practical until touchdown. Throughout the approach maintain engine rpm above 85 percent, below this power setting sufficient hydraulic pressure may not be available.

1. Fuel dump—As required.
2. Hydraulic pressure—Checked.
3. Wing sweep—Adjust slowly for landing. (1 degree per second)
4. Normal Procedures Checklists—Complete.
5. Emergency generator—As required.
6. Landing gear handle—DN.
   Allow gear to fully extend before initiating slat extension.
7. Flap/slat handle—25 degrees.
8. Final approach:
   a. Angle-of-attack—8.5 degrees.

   Note

   Approach speed will be approximately 20 knots above computed full flap approach speed.

   b. Glide slope—Normal. (Approximately 600 fpm)
   c. Angle-of-attack—On-speed when landing is assured.

Note

If runway length is critical, full flaps may be used, when landing is assured.

SINGLE ENGINE EMERGENCY GENERATOR LANDING.

During operation on emergency generator power the airspeed mach indicator, the altitude vertical velocity indicator and the angle-of-attack tape and indexers (prior to T.O. 1F-111-891) will be inoperative. Yaw and roll trim will be inoperative. The aux pitch trim switch must be used to trim the aircraft longitudinally. Hydraulic system pressures should be monitored closely throughout the approach and landing. To reduce demand on the hydraulic system, do not open or close the speed brake. Refer to "Fuel System Operation On Emergency Electrical Power," "Single Engine Landing" and "Single Engine Go-Around" procedures, this section.

1. Fuel dump—As required. (Refer to "Fuel System Operation on Emergency Electrical Power" procedures, this section.)
2. Hydraulic pressure—Checked.
3. Wing sweep—Adjust slowly for landing (1 degree per second).
4. Normal Procedures Checklists—Complete. (As applicable)
5. Flap/slat handle—25 degrees. (Normal system)
6. Emergency extension of landing gear (Refer to "Landing Gear Emergency Extension," this section).
7. Final approach:
   a. Fly approximately 20 knots above computed full flap (no aux flap) appoach speed to obtain an 8.5 degree angle-of-attack.
   b. Glide slope—Normal. (Approximately 600 fpm)
   c. Angle-of-attack indexers—On-speed when landing is assured (After T.O. 1F-111-891).

Note

If runway length is critical, full flaps may be used when landing is assured.

SINGLE ENGINE GO-AROUND.

Note

Engine acceleration time is severely affected by the amount of compressor discharge air being bled from the engine and by outside temperature. In flight this effect is minimized but during final approach for landing, engine acceleration may require as much as 10-15 seconds to increase thrust from IDLE to MIL with full bleed from the accelerating engine.

1. Throttle—Maximum. (Operating engine)
2. Air source selector—EMER. (If required)

Note

With air source selector switch in OFF or EMER, no servo air will be available for throttle boost or fuel tank pressurization. Lack of tank pressurization will degrade fuel dump rate.

3. Climb:
   a. Maintain approach airspeed until gear is retracted and all obstacles are cleared.
   b. Flaps/slats retraction—Maintain established pitch attitude constant and retract flaps/slats at a rate to maintain 8.5 degrees angle-of-attack.

WARNING

Excessive angle of attack may result from retracting flaps too rapidly.

PITOT PROBE ICING.

In the event airspeed and mach indications return to minimum values during icing conditions, the angle-of-attack indication will be correct. If the airspeed and mach indications should remain fixed during icing conditions the angle-of-attack indicator may be used for landing approach. With the mach indicator fixed at the following values, fly the angle-of-attack indicator as shown in order to maintain 10 degrees angle-of-attack.

Mach Indicator	Angle-of-Attack Indicator
0.45 thru 1.25	12 degrees
1.25 thru 1.40	11 degrees

NUCLEAR MALFUNCTION ANALYSIS.

Malfunction analysis in this section provides information to identify and correct, if possible, malfunctions which may result in a nuclear dud and/or could adversely affect the mission. Monitor and control lamp malfunctions covered are those most likely to occur, and if they do occur, would require action by the aircrew. When a malfunction has been cleared, return to normal checklist procedures. During ground operation, if malfunctions occur which are not specifically covered in this section, complete the following Bomb/Missile Safety Check.

BOMB/MISSILE SAFETY CHECK.

1. Stores control panel:
   a. Release enable switch—INHIBIT.
   b. Master switch—OFF.
   c. Selector mode knob—OFF.
   d. Delivery mode knob—OFF.
2. DCU-137/A control panel:
   a. Option select switch—OFF.
   b. Monitor and release knob—OFF.
3. Circuit breakers:
   a. External stores jettison A—Out.
   b. External stores jettison B—Out.
   c. Nuclear master—Out.
   d. Master weapons control—Out.
   e. Nuclear unlock—Out.
4. Bomb/missile rack safety pins, pivot pylon jettison ground safety lockpins, and external fuel tank pylon ground safety pins—Installed.

WARNING

After completing "Bomb/Missile Safety Check," ground safety pins must remain installed until all malfunctions are cleared.

5. Qualified personnel—Notified.

NUCLEAR CAUTION LAMP LIGHTED.

During Ground Operation:

1. Complete bomb/missile safety check.

Inflight Prior To Prearming Preparation or After Completion of Abort Checklist.

1. Option select switch—OFF.
2. If NUCLEAR caution lamp is out, proceed to step 4.
3. If NUCLEAR caution lamp remains lighted, the indication is a rack or a pylon unlocked. Proceed with the following.

Note

Circuit breakers will remain out until the "Prearming Preparation" checklist is performed.

   a. External stores jettison A and B circuit breakers —Out.
   b. Master weapons control circuit breaker—Out.
   c. Monitor and release knob—OFF.
   d. Rack or pylon cannot be locked; proceed in accordance with command policy.
4. If NUCLEAR caution lamp goes out, indication is a bomb ready/safe switch or missile SAF safe and arm device in a prearmed or intermediate position, or continuity between the weapon and aircraft monitor and control system lost. Proceed with the following:
   a. All weapon circuit breakers—In.
   b. Nuclear consent switch—OFF, guard down, sealed.
   c. Option select switch—SAFE.
   d. Station select switch—Deselected.
   e. Monitor lamps—Checked, each station.
      Rotate monitor and release knob to nuclear loaded stations and check monitor lamps to determine location and nature of the malfunction:
      (1) All monitor lamps will be out if continuity is lost or if bomb ready/safe switch or missile SAF safe and arm device is in an intermediate position.
      (2) A burst option lamp and the ARM lamp will be lighted if bomb ready/safe switch is prearmed.
      (3) ARM lamp will be lighted if missile SAF safe and arm device is armed.
   f. Option select switch—OFF.
   g. Monitor and release knob—OFF.
   h. Malfunction cannot be corrected; proceed in accordance with command policy.

Inflight After Missile Prearming.

1. DCU-137/A:
   a. UNLOCK caution lamp (selected station)—Lighted.
   b. ARM caution lamp (selected station)—Lighted.
2. Nuclear consent switch—OFF, guard down.
3. DCU-137/A:
   a. ARM caution lamp—Out.
   b. UNLOCK caution lamp—Lighted.
      Indication of a malfunction in ejector rack or pylon unlock circuits caused by:
      (1) Uncommanded pylon unlock or
      (2) CPU issued only one ejector rack unlock command (one required, two normally issued).
4. Nuclear consent switch—ARM & RELEASE.
5. ARM caution lamp—Lighted.

Note

Malfunction is not critical and does not degrade launch capability. Proceed with mission.

DCU-137/A SAFE MONITOR LAMP OFF.

During Ground Operation:

1. If the SAFE monitor lamp fails to light for any of the selected stations, proceed to step 3.
2. SAFE monitor lamp lights for some stations but not for others.
   a. Bomb/missile monitor circuit continuity may be lost.
   b. Complete bomb/missile safety check.
3. Depress malfunction and indicator lights test button and check DCU-137/A SAFE monitor lamp.
4. If SAFE monitor lamp does not light, replace the bulb and retest.
5. SAFE monitor lamp still does not light.
   a. Nuclear monitor circuit breaker in the forward equipment bay has probably malfunctioned, inhibiting monitoring.
   b. Complete bomb/missile safety check.

DCU-137/A SAFE MONITOR LAMP LIGHTED.

Immediately After Burst Option Selection/ Missile Prearming:

1. Applicable weapon circuit breakers—In.
2. Monitor and release knob—Applicable station.
3. Nuclear consent switch—ARM & REL.
4. Master switch—ON.
5. Applicable station select switch—Selected.
6. If SAFE monitor lamp remains lighted, deselect applicable station select switch.
7. Rotate option select switch to an alternate burst option compatible with mission requirements.
8. Applicable station select switch—Selected.
9. If SAFE monitor lamp remains lighted, the selected weapon cannot be prearmed. Rotate monitor and release knob to desired position and proceed in accordance with command policy.

After Receiving Correct Prearmed Indications:

1. Option select switch—Desired option.
2. Master switch—ON.
3. Depress malfunction and indicator lights test button and check that the NUCLEAR caution lamp lights.
4. Deselect applicable station select switch and observe the NUCLEAR caution lamp.
   a. If the NUCLEAR caution lamp lights momentarily, the weapons safing switch has moved to the safe position.
   b. If the NUCLEAR caution lamp did not light momentarily, the weapons safing switch was in the safe position.
5. Select applicable station select switch and observe the NUCLEAR caution lamp.
   a. If the NUCLEAR caution lamp lights momentarily, the weapons safing switch has moved to the prearmed position. Regardless of the DCU-137/A monitor lamp indications, assume the bomb to be prearmed.
   b. If the NUCLEAR caution lamp does not light momentarily, and the SAFE monitor lamp remains lighted, the weapon safing switch is in the safe position and cannot be prearmed.
6. Rotate monitor and release knob to desired position and proceed in accordance with command policy.

DCU-137/A UNLOCK MONITOR LAMP OUT.

During Selective Jettison:

1. Monitor and release knob—Applicable station.
2. Applicable weapon circuit breakers—In.
3. Depress malfunction and indicator lights test button and check that the UNLOCK monitor lamp lights.
4. Nuclear consent switch—REL ONLY.
5. Applicable station select switch—Cycled.
   Deselect applicable station select switch; then reselect station and check the UNLOCK monitor lamp.
6. If the malfunction still exists, the selected station rack or pylon locking device is in an unknown position. Proceed in accordance with command policy.

During Prearming Preparation:

1. Monitor and release knob—Applicable station.
2. Applicable weapon circuit breakers—In.
3. Depress malfunction and indicator lights test button and check that the UNLOCK monitor lamp lights.
4. Deselect applicable station select switch and check that the SAFE monitor lamp is lighted.
5. Option select switch—Desired option.
6. Select applicable station select switch and check that the UNLOCK, ARM, and bomb burst option monitor lamps are lighted.
7. If the UNLOCK monitor lamp remains out, the selected rack or pylon locking device is in an unknown position. Proceed in accordance with command policy.

DCU-137/A ARM AND/OR BOMB BURST OPTION MONITOR LAMPS LIGHTED.

After Completing Abort Procedures Checklist:

1. Nuclear master circuit breaker—In.
2. If the malfunction still exists, the selected weapon safing switch cannot be electrically safetied. Proceed in accordance with command policy.

DCU-137/A CLASS III INDICATOR/COMMAND DISAGREEMENT.

Inflight Prior To Launch.

Note

All steps are accomplished on DCU-137/A.

1. Monitor and release knob (correct missile position) —Checked.
   Class III indication will be UP if a missile station is selected that does not have a SRAM present.
2. Class III command override switch—As required.
3. Class III indicator—Checked.
   All missile positions should indicate same Class III condition. Odd indications are probably caused by a malfunctioning Class III switch in the missiles. Warhead Class III status probably agrees with DCU-137/A Class III indicator. Proceed in accordance with command guidance.

CODED SWITCH SET MALFUNCTION ANALYSIS.

Malfunction analysis by the aircrew is limited to a power and bulb check and code reentry.

Ground Operation.

1. System power—Checked.
   Insure that power is on the aircraft and that the coded switch set circuit breaker is in.
2. Lamp test button—Depressed.
   If any lamp fails to light, replace bulb.
3. Sum code—Reentered.
   Wait three minutes after initial sum code entry; then rotate thumbwheels again to the sum code.
4. Operate/monitor switch—OPER.
5. If abnormal indication persists—Request CSS custodians.
   Call command post and request CSS custodians.

Inflight Operations.

If a malfunction is noted during enabling, perform the following check.

1. Coded switch set circuit breaker—In.
2. Lamp test button—Depressed.
   If any lamp fails to light, replace bulb.
3. Enable code—Reentered.
   Wait three minutes after initial enable code entry; then rotate thumbwheels again to the enable code.
4. Operate/monitor switch—OPER.
5. If malfunction persists—Obtain and enter alternate enable codes.
   Using applicable procedures, attempt to obtain alternate enable codes. Enter codes observing three minute wait between code entries.

Note

Several CSS enablings may be attempted. Once the system is enabled, the aircrew cannot disenable the system inflight by repeated code entry.

6. If malfunction persists—At prearming point/MPL attempt weapon prearming.

Note

A prearmed indication on the DCU-137/A panel indicates a valid prearming regardless of lamp indications on the CSSC. If a prearmed indication cannot be obtained, perform applicable nuclear malfunction analysis and proceed as directed in command tactical doctrine.

Caution Lamp Analysis

Indicator	*Cause*	*Corrective Action*
α/β PROBE HEAT (On aircraft 53 ▶ and those modified by T.O. 1F-111-708, this lamp is disabled above mach 1.10.)	On the Ground: 1. Pitot/probe heater switch OFF/SEC. 2. Primary heater in angle-of-sideslip or angle-of-attack probe overheated.	1. Momentarily place the heater switch to HEAT to verify that heaters are functioning as indicated by the lamp going out. 2. Place switch to OFF/SEC and allow probe to cool. Lamp will remain lighted due to being in OFF/SEC.
	In Flight: 1. Primary heater in angle-of-attack or angle-of-sideslip probe not functioning with probe heat sw in HEAT. 2. Secondary heater in angle-of-attack or angle-of-sideslip probe not functioning with probe heat switch in OFF/SEC.	1. Place pitot/probe heater switch to OFF/SEC. 2. Cycle switch back to HEAT. In icing conditions, if lamp remains lighted, consider angle-of-attack indicator, TFR, and AYC inoperative. Place flight control disconnect switch to OVRD prior to extending slats or placing flight control switch to T.O. & LAND for landing.
ANTI-SKID	Indicates gear down with switch off or anti-skid inoperative.	Check switch on. Recycle to OFF then on. If lamp remains on, place switch to OFF and avoid hard braking during landing roll.
(After T.O. 1F-111(B)A-637) ATTITUDE	1. If no other fault is indicated, INS and AFRS attitude data disagrees by more than 7 ($\pm$1.4) degrees in pitch or roll. 2. If the ADI flag is in view, an ADI malfunction is indicated.	1. Return to straight and level flight, determine which system/indicator is reliable, and use that system/indicator for remainder of flight. 2. Use the standby attitude indicator for remainder of flight.
(After T.O. 1F-111(B)A-637) ATTITUDE AND PRI ATTITUDE	1. If ADI flag is in view, an INS and an ADI malfunction is indicated. 2. If the ADI flag is out of view, both an INS and an AFRS malfunction is indicated.	1. ADI is unreliable. Use standby attitude indicator for remainder of flight. 2. Attempt to restore the INS function by performing INS alignment procedures ("DCC Recovery and INS Inflight Alignment Procedures" Section IV) or re-erect the AFRS gyro using the AFRS gyro fast erect button.

★ *Figure 3-4. (Sheet 1)*

Caution Lamp Analysis (Cont'd)

Indicator	*Cause*	*Corrective Action*
(After T.O. 1F-111(B)A-637) ATTITUDE AND AUX ATT	1. If ADI flag is out of view, an AFRS malfunction is indicated.	1. Verify flight instrument reference select switch is in PRI. The standby indicator will be unreliable. Verify that the AFRS circuit breaker is set whenever the AUX ATT lamp goes out after being lighted. Failure of the INS with the AFRS circuit breakers out, results in inaccurate signals to the ADI.
	2. If the ADI flag is in view, both AFRS and ADI malfunctions are indicated.	2. Attempt to re-erect AFRS gyro by using the AFRS gyro fast erect button and use standby attitude indicator for remainder of flight.
	3. Electrical power interruption causing AFRS gyros to fast erect (ADI flag in view), or an intentional fast erect of AFRS using the fast erect button.	3. Maintain unaccelerated straight and level flight during the fast erection period (normally 2 minutes) to prevent erection to a false vertical.
(After T.O. 1F-111(B)A-637) ATTITUDE AND PRI ATTITUDE AND AUX ATT	Malfunction of both INS and AFRS is indicated.	Attempt to restore INS function by performing the INS alignment procedures ("DCC Recovery and INS Inflight Alignment", Section IV) or re-erect the AFRS gyro using the AFRS gyro fast erect button.
AUX ATT	1. AFRS attitude information unreliable.	1. Verify flight instrument reference select switch is in PRI. The standby attitude indicator will be unreliable. Verify that the AFRS circuit breaker is set whenever the auxiliary attitude caution lamp goes out after being lighted. Failure of the B/N system with AFRS circuit breakers out, results in inaccurate signals to the ADI.
	2. Elect power interruption causing AFRS gyros to fast erect (off flag in view) or an intentional fast erect of AFRS using the fast erect button.	2. Maintain unaccelerated straight and level flight during the AFRS fast erection period (normally 2 minutes) to prevent erection to a false vertical.
PRI ATTITUDE	Failure of inertial set or inertial nav not selected, or AUX selected.	System automatically switches to AUX. Caution lamp will remain lighted whenever switch is not in PRI.
CABIN PRESS	Cabin altitude above 10,000 feet.	Check oxygen equipment. Assure oxygen is on. Check that pressurization selector switch is in NORM. Don oxygen mask and descend to or below 25,000 feet before continuing flight.

★ *Figure 3-4. (Sheet 2)*

Caution Lamp Analysis (Cont'd)

Indicator	*Cause*	*Corrective Action*
CADS	One of CADC monitors indicates malfunction. Also indicates loss of power to MSMA.	Cross check flight instruments to determine if any are inoperative. Use standby instruments in lieu of malfunctioning primary instruments. Use mach or altitude hold modes with caution. Also suspect loss of power to MSMA and observe structural limit speeds.
ROLL CHANNEL AND/OR PITCH CHANNEL AND/OR YAW CHANNEL	1. One of the triple redundant channels is in error. 2. Pitch, roll or yaw computer power supply failure.	1. Depress the damper reset button momentarily. If lamp resets, continue normal operation. For a pitch channel lamp that will reset, verify that the lamp does not come on during an intentionally induced fly-up maneuver at MEA or above before continuing TF operation. If lamp does not reset, change speed to a stability augmentation off region, turn the affected damper OFF and land as soon as practicable. 2. For a yaw channel lamp that does not reset, do not fly auto or manual TF since aircraft response to climb/dive signals, loss of TF fly-up capability, loss of ref not engaged and fly-up off caution lamps may have occurred. In addition, the pitch and roll autopilot operation may be affected. Therefore autopilot performance should be closely monitored if engaged. 3. If any of the three channel lamps remain lighted, change speed to a stability off region, turn the affected damper OFF and land as soon as practical.
ALL 3 LIGHTED	Loss of one ac pwr source and loss of redundancy.	Decelerate to less than 320 KIAS and land as soon as practicable.
YAW CHANNEL (With slats extended)	One of the redundant AYC signals has a single failure.	Depress the damper reset button; if lamp resets continue normal operation. If lamp does not reset place the flight control disconnect switch to OVRD which terminates AYC. Reset the lamp. If lamp resets, continue operation. If slats are subsequently retracted, place the flight control disconnect switch to NORM and continue. If the lamp does not reset, turn the affected damper OFF and land as soon as practicable.

Figure 3-4. (Sheet 3)

Caution Lamp Analysis (Cont'd)

Indicator	*Cause*	*Corrective Action*
ROLL DAMPER OR PITCH DAMPER OR YAW DAMPER	One of the triple redundant commands to a damper servo is in error.	Depress damper reset button momentarily, if lamp does reset, continue normal operation. For a pitch damper lamp that will reset, verify that the lamp does not come on during an intentionally induced fly-up maneuver at MEA or above before continuing TF operation. If lamp does not reset, reduce speed to the applicable stability augmentation off limits, turn affected damper off and land as soon as practicable. If pitch damper lamp will not reset, do not fly manual or auto TF.
ROLL, PITCH & YAW DAMPER (With both PRI or both UTIL HYD sys caution lamps)	One hydraulic system pressure is low.	Reduce speed to damper off operating region. Monitor hydraulic pressure. Depress damper reset button only if affected system pressure returns to normal. Damper operation will not be affected. Follow normal operating procedures. Sweep wings forward at reduced rate to prevent hydraulic pressure depletion. Refer to "Hydraulic System Failure," this section.
PITCH OR ROLL GAIN CHANGER	One of the redundant roll or pitch gain changers is in error (if both lamps light, see following).	Depress damper reset button momentarily. If lamp resets, continue normal operation. If lamp does not reset, decrease speed to less than 425 KIAS/mach 0.80, whichever is less. If subsequent 2 cps oscillation occurs, decelerate.
PITCH GAIN CHANGER AND ROLL GAIN CHANGER	1. Gear handle DN but flight control system not in takeoff and land configuration. 2. Slats retracted and control system still in takeoff and land configuration.	1. Extend slats, if lamps stay on place control system switch to T.O. & LAND to override the automatic switching. If lamps still remain lighted, place rudder authority sw to FULL to insure full nose wheel steering. If the flt control sw is in OVRD, the lamps will remain lighted. 2. Check that control system switch is in NORM, and gear handle is up. If lamps remain lighted, the flight control system is locked in T.O. & LAND. Place the flight control disconnect switch to OVRD if the wing sweep is aft of 26 degrees. Do not exceed 300 KIAS and land as soon as practicable. Do not fly TFR.
RUDDER AUTHORITY	Rudder authority differs from that programmed when the control system switch is in the T.O. & LAND position or differs from that called for by slat position when control system switch is in NORM.	Check rudder authority switch in AUTO. If lamp remains lighted, the rudder authority may be unscheduled. At high speeds, exercise caution in the use of rudder pedals. For landing, if lamp remains lighted, place the rudder authority switch to FULL. If the lamp still remains lighted, rudder and nose wheel steering authority may be limited.

Figure 3-4. (Sheet 4)

Caution Lamp Analysis (Cont'd)

Indicator	*Cause*	*Corrective Action*
PRI LOW SPOILER OFF 53 ♦	Deactivated.	
UTIL LOW SPOILER OFF 53 ♦	Deactivated.	
PRI LOW SPOILER OFF UTIL LOW SPOILER OFF 53 ♦	Deactivated.	
FUEL DISTRIB	Fuel distribution out of limits. Fuel distribution control system failure. Alternate fuel distribution monitor system failure.	Select AFT feed. If lamp goes out, indication is from automatic fuel distribution control system. If lamp remains on indication is from alternate fuel distribution monitoring system. Refer to "Abnormal Fuel Distribution" this section.
FUEL LOW	Usable fuel in fuselage reservoir tank is 2300 (±235) pounds or less.	Transfer any available fuel into forward fuselage tank. If no other fuel is available, land as soon as possible. Fuel conditions may vary when this lamp lights. Evaluate the condition and take necessary action.
L FUEL PRESS R FUEL PRESS	Affected fuel manifold pressure is less than 15.5 PSIA. Improper engine feed selector. Boost pump malfunction.	Check fuel feed selector knob, fuel tank pressurization switches and fuel pump pressure lamp. If the boost pump pressure lamp is lighted, reduce throttle and recheck the L fuel press and R fuel press caution lamps for indication. If lamps remain on, refer to "Low Fuel Press Lamp Lighted," this section.
TANK PRESS	Fuel tank pressurization is not compatible with aircraft configuration.	Place fuel tank pressurization selector switch to appropriate position to cause the lamp to go out. Monitor fuel quantities and assure that pressure loss has not affected fuel quantity or distribution.
FWD EQUIP HOT	GROUND OPERATION 1. Low airflow at low engine power settings. 2. Icing of water separator during prolonged idle operation with high humidity conditions.	1. Increase eng pwr slowly (80% rpm on both engines is sufficient) until lamp goes out. 2. Direct GO to depress self-test button on the −65° hot air cont valve located on the aft bulkhead of the wpns bay, or place engine/inlet anti-icing sw to MANUAL. Lamp should go out within 2 minutes, then reposition anti-icing sw as required.

Figure 3-4. (Sheet 5)

The purpose of this section is to provide a compact collection of material wherein each crew member can readily determine his duties in relation to the accomplishment of the over-all mission. Instructions relating to crew duties do not include information which is already covered in other sections.

CREW COORDINATION.

Note

- Items coded **B** are applicable to both the pilot and navigator. Items coded **P** are applicable to the pilot only and uncoded items are applicable to the navigator only.
- Items coded † must be checked against the applicable weapon delivery manual and individual aircraft retrofit to determine applicability.

Coordination of actions within a crew is of prime importance to insure the optimum degree of mission success and safety during all phases of operation. This coordination is not necessarily limited to actions alone. Complete familiarity with one's crew position, the responsibilities thereof and a working knowledge of the other crew member's duties will contribute immeasurably toward crew coordination. Each crew member must be constantly on the alert and should notify the responsible crew member of any deviation or discrepancy which will affect successful accomplishment of the mission. Liaison between individuals concerned must be established prior to initiating any action or procedure which will alter aircraft configuration or require correlation of activities between crew members. Prior to flight both crew members must be thoroughly familiar with all aspects of the assigned mission as pertains to their crew specialty to include:

1. Applicable instructions in the flight information publications.
2. Route of flight.
3. Navigation.
4. Air refueling information.
5. Bombing/Missile launch.
6. ECM activities.
7. Normal and emergency communications procedures.
8. Penetration, approach, missed approach, landing patterns, altitudes, and obstructions at both destination and alternate airfields.

Prior to accomplishment of any of the following, coordination between crew members will be required when:

1. Changing fuel control settings.
2. A function or mode is selected which could affect aircraft control or command steering displays.
3. Flight conditions require a change in wing sweep.
4. Changing TFR controls.

COMMUNICATIONS.

The pilot will make the necessary calls for taxi instructions and will receive and acknowledge the ARTC clearance. He will also normally make the necessary calls to departure and approach control. The navigator will monitor communications at all times, and assist with communications when required. During takeoff and other critical phases of flight the navigator will set his interphone control panel so as to be able to monitor UHF 1 and UHF 2.

LOW ALTITUDE NAVIGATION.

Special emphasis will be directed to maintain route corridor, proper airspeed and prescribed altitudes. The navigator will announce the heading, MEA, and ETA and/or ETE to next turn point. The pilot will monitor airplane position and take necessary action to insure corridor limits are not exceeded.

Caution Lamp Analysis (Cont'd)

Indicator	*Cause*	*Corrective Action*
HOOK DOWN	Hook is not up and locked.	Land past the approach end barrier. Hook cannot be retracted in flight.
PRI HOT UTIL HOT	Indicated hydraulic system fluid temperature is above 230°F (110°C).	Reduce demand on the hydraulic system. Reduce speed and land as soon as practicable.
L PRI HYD R PRI HYD	Pressure output of the indicated primary hydraulic pump is below 400 to 600 PSI.	Monitor hydraulic pressure. If it is normal, land as soon as practicable. If abnormal pressure, refer to "Hydraulic System Failure," this section. Damper oper will not be affected.
L UTIL HYD R UTIL HYD	Pressure output of the indicated utility hydraulic pump is below 400 to 600 PSI.	Monitor hydraulic pressure. If it is normal, land as soon as practicable. If abnormal pressure, refer to "Hydraulic System Failure," this section. Damper oper will not be affected.
ICING	1. Icing condition sensed by ice detector. 2. Malfunction of ice detection system.	1. Check that engine inlet anti-icing system is operational by placing engine/inlet and anti-icing switch to OFF then to AUTO. If system is operational, above 8000 feet there will be a 300 to 500 feet fluctuation in cabin pressure when cycling the switch. There will also be a noticeable decrease in EPR when system is turned OFF and back to AUTO. If not, go to MANUAL. Lamp will remain lighted until 60 seconds after icing condition ceases. 2. If icing conditions are not present turn anti-icing system off.
IFF	Mode 4 inoperative or improperly comparing code.	1. Check that master control knob is in NORM, mode 4 control switch is in ON, and proper A or B code is selected. 2. Take action to obtain IFF identification on other modes.
INLET HOT	Anti-icing air temperature excessive.	Shut off engine inlet anti-icing. Lamp should go out. If not, slow aircraft to reduce total temperature.
NUCLEAR	Refer to T.O. 1F-111(B)A-25-2.	
L ENG OIL HOT R ENG OIL HOT	1. Oil temperature of affected engine exceeds 250°F (121°C).	1. If oil pressure drops below 30 psi, or lamp persists for more than 10 seconds after retarding to IDLE, shut down the engine and land as soon as practicable. With normal oil pressure following a thrust reduction, advance throttle to a higher setting, if possible. If lamp persists for two minutes, retard to IDLE and monitor oil pressure. If lamp persists for more than 10 seconds after

Figure 3-4. (Sheet 7)

Caution Lamp Analysis (Cont'd)

Indicator	*Cause*	*Corrective Action*
L ENG OIL HOT R ENG OIL HOT (Cont'd)	 2. Under some conditions this could also be caused by a broken hot air bleed line.	retarding to IDLE, shut down the engine and land as soon as practicable. During grou•d operation, advance throttle to a higher setting, if lamp persists for two minutes, retard to IDLE and monitor oil pressure. If lamp persists for more than 10 seconds after retard to IDLE, shut down the engine. 2. If under steady state conditions, the lamp lights, consideration should be given to shutting down the engine.
OIL LOW	Oil level in either engine down to 4 quarts.	Check oil quantity indicators. Shut down affected engine if not needed. If engine needed, shut down when oil pressure starts to drop.
L ENG OVERSPEED R ENG OVERSPEED	Excessive low press comp rpm. (As a self test feature, lamp is lighted when eng is below idle rpm.)	Retard throttle of affected engine. Lamp should go out at reduced power. If lamp remains lighted, operate engine at reduced power.
OXY	Total liquid oxygen remaining is two liters or less or pressure is 42 psi or less.	Descend to a safe altitude and monitor oxygen supply.
PRI HEADING	1. Fail-of DCC if PRI ATT not lighted. 2. INS failure.	1. Both computers (GNC & WDC) pwr switches must have been turned OFF in accordance with "Avionic System Analysis." System will sw to AUX heading and PRI HDG caution lamp will light after above action. 2. System automatically switches to AUX. The lamp will remain lighted if switch is not in PRI. Verify that AFRS circuit breaker is set if PRI HDG caution lamp goes out after being lighted. Failure of INS with AFRS circuit breakers out, results in inaccurate signals to the ADI & HSI.
L ENG SPIKE R ENG SPIKE	Mach 0.35 or below, and the affected spike has not contracted or is not full forward.	Position appropriate spike control switch(es) to OVERRIDE. Do not attempt to return to NORM position after the spike control switch has been placed to OVERRIDE.
SPOILER	One pair of spoilers has been voted out and locked down.	Maintain positive control of aircraft attitude and decelerate to safe speed. Attempt to reset spoiler one time only but expect a rapid roll transient if spoiler is still failed. A spoiler that

Figure 3-4. (Sheet 8)

Caution Lamp Analysis (Cont'd)

Indicator	*Cause*	*Corrective Action*
SPOILER (Cont'd)		was voted out because of an active failure will not likely reset. The roll rate capability during landing will be reduced by approximately 50 percent.
TF FLY UP—OFF	TF Fly-Up is not available due to one of the following conditions: (1) Control system switch in T.O. & LAND. (2) Slats are extended. (3) Auto TF switch is in AUTO TF but TFR set is not in TF. (4) The fly-up circuit not armed.	Check switch positions. If light persists, do not fly manual or auto TF.
TOTAL TEMP	Total temp above 153°C.	Monitor total temperature indicator for "seconds to go" (five minutes allowable). Reduce speed after five minutes or when the REDUCE SPEED warning lamp lights.
WHEEL WELL HOT	Wheel well, weapons bay routing tunnel and/or a-c power panel area overheat condition. (Possible rupture of engine bleed air duct).	Position air source selector to EMER and decelerate to subsonic. If lamp persists for more than 10 seconds extend speed brakes, lower gear. Land as soon as practicable.
WINDSHIELD HOT	Rain removal air exceeds 450°F.	Place rain removal switch to OFF and reduce pwr below 80%. If after 15 seconds the caution lamp is still lighted, place the air source selector to EMER (RAM if EMER not installed) and observe Ram or Emer Mode Flt Limits, Section V.
TURN/G LIMIT	1. The aircraft is executing a turn in which the heading rate exceeds a value (±2 degrees per second) for which the TFR can properly compensate the climb dive commands. 2. The roll compensated climb command exceeds the preselected safe pull up "g" limit by more than 5 percent.	Reduce bank angle or climb command until lamp goes out. If lamp does not go out, consider the condition as a TFR failure.
VELOCITY	Indicates groundspeed input to the TFR differs from true airspeed by 130 knots or more.	Change indicated mach to between 0.70 and 0.90.

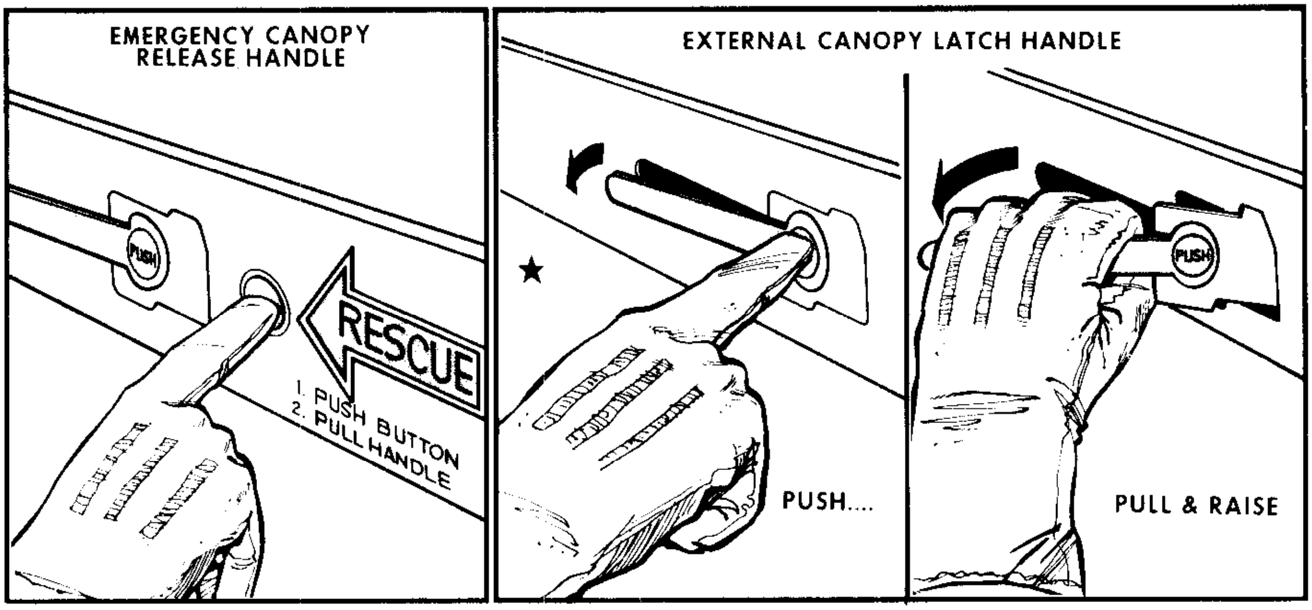
Figure 3-4. (Sheet 9)

Caution Lamp Analysis (Cont'd)

Indicator	*Cause*	*Corrective Action*
FLT VECTOR	1. Malfunction in CADC. 2. Inertial nav mode not selected. 3. Malfunction in INS or DCC.	Discontinue TFR unless visual flight conditions exist until effect on system operation is determined.
TF DRIFT	Inertial and doppler drift inputs to the TFR differ by 4 (±0.5) degrees.	The TFR antenna is caged to the aircraft centerline and not necessarily looking along ground track. When lamp is lighted, do not fly TFR under IFR conditions unless drift is less than 3°. IF TFR flight is continued with lamp lighted, restrict bank angles to 10° or less.
SRAM		Refer to "AGM-69 System Analysis," Section IV.

Figure 3-4. (Sheet 10)

Emergency Entrance



1. Push plunger to unlock internal handle.

2. Push in on external handle to extend.

3. Grasp handle to raise hatch.

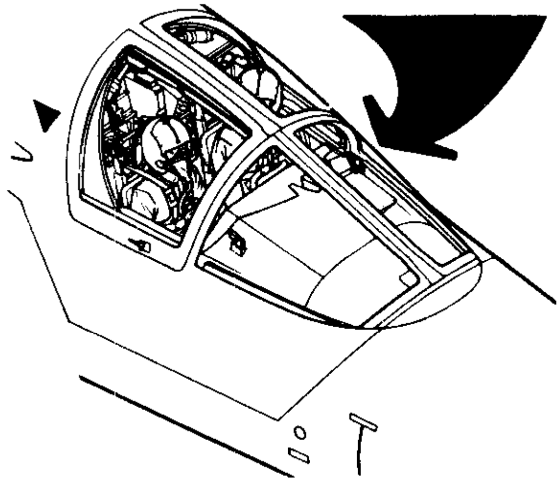


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Figure 3-5.

This is the last page of Section III.

SECTION IV

CREW DUTIES

TABLE OF CONTENTS.

The purpose of this section is to provide a compact collection of material wherein each crew member can readily determine his duties in relation to the accomplishment of the over-all mission. Instructions relating to crew duties do not include information which is already covered in other sections.

CREW COORDINATION.

Note

- Items coded **B** are applicable to both the pilot and navigator. Items coded **P** are applicable to the pilot only and uncoded items are applicable to the navigator only.
- Items coded † must be checked against the applicable weapon delivery manual and individual aircraft retrofit to determine applicability.

Coordination of actions within a crew is of prime importance to insure the optimum degree of mission success and safety during all phases of operation. This coordination is not necessarily limited to actions alone. Complete familiarity with one's crew position, the responsibilities thereof and a working knowledge of the other crew member's duties will contribute immeasurably toward crew coordination. Each crew member must be constantly on the alert and should notify the responsible crew member of any deviation or discrepancy which will affect successful accomplishment of the mission. Liaison between individuals concerned must be established prior to initiating any action or procedure which will alter aircraft configuration or require correlation of activities between crew members. Prior to flight both crew members must be thoroughly familiar with all aspects of the assigned mission as pertains to their crew specialty to include:

1. Applicable instructions in the flight information publications.
2. Route of flight.
3. Navigation.
4. Air refueling information.
5. Bombing/Missile launch.
6. ECM activities.
7. Normal and emergency communications procedures.
8. Penetration, approach, missed approach, landing patterns, altitudes, and obstructions at both destination and alternate airfields.

Prior to accomplishment of any of the following, coordination between crew members will be required when:

1. Changing fuel control settings.
2. A function or mode is selected which could affect aircraft control or command steering displays.
3. Flight conditions require a change in wing sweep.
4. Changing TFR controls.

COMMUNICATIONS.

The pilot will make the necessary calls for taxi instructions and will receive and acknowledge the ARTC clearance. He will also normally make the necessary calls to departure and approach control. The navigator will monitor communications at all times, and assist with communications when required. During takeoff and other critical phases of flight the navigator will set his interphone control panel so as to be able to monitor UHF 1 and UHF 2.

LOW ALTITUDE NAVIGATION.

Special emphasis will be directed to maintain route corridor, proper airspeed and prescribed altitudes. The navigator will announce the heading, MEA, and ETA and/or ETE to next turn point. The pilot will monitor airplane position and take necessary action to insure corridor limits are not exceeded.

PILOT'S DUTIES.

The pilot is the crew commander and is responsible for the aircraft and crew. The successful accomplishment of the mission is of prime importance; in no instance, however, will the safety of the aircraft or crew be compromised. The pilot is responsible for the issuance of instructions governing all phases of flight operation. In addition to his regular function, the pilot will perform the following:

MISSION PREPARATION.

1. Attend general briefing.
2. Coordinate with navigator on route charts, targets, items pertinent to individual crew procedures, and supervise the completion of required forms.
3. Complete form 175.
4. Coordinate with navigator to establish position reporting points and cruising altitudes.
5. In conjunction with the navigator, verify aircraft weight and balance, compute takeoff, inflight, and landing performance data. Complete the Takeoff and Landing Data Card in the Flight Crew Checklist, T.O. 1F-111(B)A-1CL-1. Recheck data just prior to flight to determine the effects of atmospheric, runway, or aircraft configuration changes. If required, revise Takeoff and Landing Data Card to reflect latest information.
6. Attend specialized briefing.

PREFLIGHT AND OPERATING PROCEDURES TO LEVEL-OFF.

Accomplish the checklists and procedures as outlined in Section II. The navigator will read checklists as required or at the pilot's request.

CRUISE.

1. Monitor navigation to insure knowledge of airplane position at all times.
2. Monitor fuel transfer and distribution, gross weight, and actual fuel consumption versus predicted.
3. Analyze incidents or discrepancies which necessitate changes of flight plan and make appropriate decisions.
4. Monitor all engine and systems instruments periodically.
5. Insure that position reports and required GCI, RBS, and HF radio contacts are completed.
6. Accomplish station checks periodically as follows:
   a. Oxygen and cabin altitude—Checked.
   b. Instrument cross check — Altimeters, airspeed, attitude, heading system, and engine instruments.
   c. Circuit breaker panel—Checked.
   d. Generator control panel—Checked.

AIR REFUELING.

Perform air refueling checks as outlined in the Air Refueling Flight Manual, and complete the refueling operation as briefed.

BOMB RUN.

1. Establish and maintain bomb run air speed and altitude.
2. Coordinate with the navigator to accomplish bomb run procedures.
3. Call time-to-go driving and at 60, 30, 10, and 0. Request tone on at approximately 10 seconds time-to-go (RBS only).
4. After bomb release, perform escape maneuver, if applicable.

DESCENT, LANDING AND POSTFLIGHT PROCEDURES.

Accomplish the checklist and procedures outlined in Section II.

NAVIGATOR'S DUTIES.

The navigator must work continuously with the pilot to insure successful completion of the mission.

During all critical phases of flight the navigator will monitor all flight and engine instruments to insure immediate recognition of a dangerous condition and so advise the pilot. Where specific procedures require cross-checking of flight instruments, the navigator will use the standby instruments as his reference.

A separate checklist is provided for nuclear and conventional missions. The nuclear checklist will be carried for EWO and training missions. The conventional checklist will be carried on all conventional bombing missions.

MISSION PREPARATION.

1. The general mission planning should be accomplished with the assistance of the PILOT.
2. Attend general briefing.
3. Obtain necessary metro data for route and target area to include:
   a. Wind and temperature data for all phases of the flight.

b. Navigation and fuel planning may be accomplished using climatic data. The low altitude portion (high penetration fix to high exit fix) of the flight plan will be completed using a no wind condition and standard day temperature.

4. Select maps and charts of suitable scale and projection as directed by the requirements of the mission. Additional charts should be available to provide coverage for emergency changes in the flight plan.
5. The complete route will be plotted on charts, from initial level off to the initial approach fix.
6. The mission flight plan will be prepared in 2 copies.
   a. One copy will be delivered to the Current Ops Section. The Current Ops Section will be responsible for cutting the tape from the flight plan and delivery to Maintenance. The tape will be loaded in the aircraft by maintenance personnel prior to crew station time.
   b. One copy will be retained by the crew for use inflight.
7. The Mission Flight Plan will be completed in accordance with the following instructions:
   a. Show all times and dates in Zulu. Enter duration of flight as logged in form 781. Record winds/altitude structure used to compute flight plan in the remarks section.
   b. Each line of the flight plan provides for automatic flight tape data and navigation/performance data for one leg or flight condition. On load and off load lines will be provided to facilitate fuel computations associated with air refueling and stores release. A check mark (✓) may be used to indicate no change from the preceding entry. Blocks not requiring specific entry may be left blank.
      (1) SEQ—Enter appropriate D.T.O. and sequence number.
      (2) TC—Enter true course in three digits.
      (3) NAME—Enter the description (IP, TGT, ARCP, ETC.) of the action point if applicable. Also enter the VORTAC/TACAN and the radial and distance used for position reporting. The TACAN channel number may be entered.
      (4) MC — Enter magnetic course in three digits.
      (5) ALT—For cruise/descent/climb legs, enter the altitude for the end of the leg.
      (6) MACH—For cruise legs, enter MACH NO. or IAS for end of leg, as applicable. For legs involving changing MACH NUMBERS, VAR (variable) may be entered.
      (7) TAS, GS — Enter computed TAS and ground speed.
      (8) DIST—Enter ground distance for the leg. For supersonic releases, which require a breakaway, enter ground distance from level off to the BRL. For timing delays, enter zero ground distance.
      (9) TIME—Enter time required for the leg.
      (10) ATA, ETA — ATA will be used in flight to record time of arrival. Enter ETA to the end of each leg.
      (11) ACT FUEL, EST FUEL — ACT FUEL will be used to record the fuel on board at appropriate intervals in flight as required. EST FUEL will be used to record computed fuel on board at the following points. (When applicable)
         (a) Initial Level Off at cruise altitude.
         (b) Air Refueling Control Point. (ARCP)
         (c) End Air Refueling Point.
         (d) Primary/alternate entry control point (Oil Burner) or start descent point (VFR low level routes) for low level operation.
         (e) High exit fix (Oil Burner) or level off at cruise altitude (VFR low level routes).
         (f) Initial Approach fix.
         (g) At intervals not to exceed one hour high altitude or 30 minutes low level.
      (12) FUEL, GW—The fuel and gross weight columns will be used to compute the fuel on board:
         (a) General—Round off all fuel and gross weight figures to the nearest 100 pounds.
         (b) For climbs, subtract 200 pounds fuel from the charted value when starting climbs from between 2500 feet and 3000 feet. The chart is based on climbs from sea level. Disregard climbs of less than 5000 feet. Cruise at the new altitude from the start climb point.
         (c) For cruise, use average gross weight for determining cruise fuel if the leg is longer than 30 minutes subsonic.
         (d) Supersonic—If a climb is planned, accelerate to supersonic climb speed. Use average gross weight for determining cruise fuel if the leg is over five minutes. Use five minutes, 55 NM, 200 pounds of fuel

and 540 KIAS for deceleration and descent from supersonic altitudes and maximum speeds to subsonic altitudes and speeds.

(e) Air refueling—Disregard descent for air refueling and compute fuel consumption at the lower altitude from the start descent point. Use the Time and Range During Refuel chart for fuel computations. Use 200,000 pounds tanker gross weight and average the receiver gross weight.

(f) In descents, disregard descents of less than 10,000 feet. Compute fuel using the new altitude from the start descent point.

(g) For low level tactical operations, fuel may be computed using the following procedure: Compute a single average altitude for the low level route; i.e., between the low level entry point (Oil Burner/VFR routes) and the exit point (Oil Burner)/start climb point (VFR route). Use the appropriate IFR or TFR altitude profile, whichever is anticipated to be flown, for this altitude computation. Fuel computation, between the primary/alternate entry control point (Oil Burner) or start descent point (VFR low level routes) and the high altitude exit fix (Oil Burner) or the level-off at cruise altitude (VFR low level routes), may be made using this single average altitude and the applicable mach number.

(h) Use 1000 pounds fuel from the final initial approach fix to initial low approach or landing. If additional traffic pattern work is planned, use 6000 pounds per hour to compute final landing fuel.

(13) AIR DIST — Enter air distance for the leg. For supersonic releases, which require a breakaway, enter air distance from level off to the BRL.

c. Dest/TGT/offset fixpoint table data (reverse side of form).

(1) SEQ—Enter D, T, O or F for destination, target, offset or fixpoint, and the sequence number for the data coordinates.

(2) DATA—Enter the data number for the data point coordinates.

(3) LATITUDE—Enter N or S and the coordinate to the nearest .01 minute.

(4) LONGITUDE—Enter E or W and the coordinate to the nearest .01 minute.

(5) ELEV—Enter a + or a — and the elevation of the data point coordinates.

d. WEAPONS LOCATION AND ID (reverse side of form).

(1) STORE STATION — 1 through 8 are pylon stations, 0 and 9 are left and right bay respectively.

(2) WEAPON ID CODE — Enter the ID number for the weapon from the weapon table (two digits).

(3) BURST ALTITUDE (FEET) — Enter from 0 to 20,000 feet to the nearest 100 feet (three digits).

(4) PROXIMITY BURST CODE — For radar fusing enter 0 and for pressure altitude fusing enter 1.

(5) WEAPON YIELD CODE — For conventional weapons enter 0, for nuclear weapons enter yield code (one digit) from the nuclear weapon yield code table. Enter a yield code of 9 for all RBS operations.

(6) WEAPON CONSTANTS ADDRESS — Enter four alphanumerics associated with weapon ID from weapon table (does not apply when manually inserting data). Refer to T.O. 1F-111(B)A-25-3.

8. The navigation chart(s) will contain the following annotations:

a. Sequence numbers for all programmed destinations, targets, and fix points. Fix points will be spaced at intervals no greater than 300 NM for high altitude navigation and 150 NM for low altitude navigation. If possible, the fix points will be within 15 NM of the planned course.

b. Position reporting points when other than planned turn points.

c. Climb, descent, level off, acceleration, and deceleration for low altitude and supersonic activity.

d. Receiver IP (ARIP/RZIP), air refueling control point (ARCP), and end air refueling point (END A/R).

e. Restricted, warning, and prohibited areas within 25 NM of the planned route and within the planned FLIP altitude structure will be clearly marked as to time and altitude limitations.

f. Altitude calibration points, with terrain elevation noted, for bombing.

g. PCTAP and HHCL.

h. Emergency airfields.

i. In addition to above requirements and those listed in applicable directives, the low level chart(s) will contain the following:
   (1) Flight altitudes for each segment of the route during penetration and withdrawal.
   (2) ETE between points of planned heading/altitude changes.
   (3) Clearance setting for planned TFR flight.
   (4) Earliest SRAM launch point.

9. Accomplish target study and planning for normal and emergency bombing on each target as applicable, and complete the bombing data form in accordance with the instructions in the appropriate weapon delivery manual.
10. AILA planning will be accomplished, using plate in current FLIP terminal high altitude charts.

PREFLIGHT AND OPERATING PROCEDURES TO LEVEL-OFF.

1. Accomplish checklist and procedures as outlined in Section II.

CRUISE.

Crew duties and environment are not conducive to manual recording of in-flight data; however, certain items must be recorded on the mission flight plan as indicated below. Mission replot can be completed by using the mission flight plan and film.

Note

During deviations from flight plan route, enough information will be recorded on the mission flight plan/chart so that the aircraft flight path and profile can be fully reconstructed.

1. Coordinate with the pilot periodically on aircraft position, heading and ground speed. Record ATA's for each entry on the flight plan that has an ETA (except while low level). (A check mark will suffice if the ATA is within one minute of the ETA).
2. Monitor penetration, low level headings, altitudes, and withdrawal procedures.
3. Coordinate on communications procedures as necessary.
4. Accomplish station checks periodically as follows:
   a. Oxygen and cabin altitude—Checked.
   b. Instrument crosscheck—Altimeters, airspeed, attitude, heading system, and engine instruments.
   c. Circuit breaker panel—Checked.
5. Monitor fuel transfer and distribution, gross weight, and actual fuel consumption versus predicted. Record total fuel remaining for each entry on the flight plan that has a required EST FUEL entry.

AIR REFUELING.

1. Conduct rendezvous using applicable Tech Order.
2. Monitor aircraft position.
3. Advise pilot concerning fuel loading, configuration, and fuel on-loaded.

BOMBING.

1. Perform required checklists and procedures as outlined in this section.
2. Coordinate with the pilot in completion of the checklist and use of the tone switch for RBS activity.
3. At bombs away, the navigator will insure that weapon release is obtained. The pilot's and navigator's bomb release lamps will light when a release signal is present. The station selected and stores present lamp and all DCU-137/A lamps will go out when the bomb is released. All pertinent bombing data will be recorded and timing will be initiated if required.
4. Alternate bombing procedures:
   When the status of the DCC is such that a synchronous bomb run cannot be accomplished, the system must be evaluated and the bomb run completed by the most accurate and reliable means remaining. Some other methods of release are:
   a. Computer:
      If the DCC is operational, but the radar is unusable, a computer bomb run may be accomplished using the "Synchronous Bomb Run" checklist.
   b. Timing:
      Some alternate bomb runs are basically timing runs and the "Alternate Bomb Run" checklist will be used. Bombing by timing is primarily a method of bombing by establishing a track and determining an ETA to the bomb release point. Timing can be initiated when the target or timing point is coincident with a fixed range marker/cursor. Release is made upon the expiration of a precomputed time from the fixed range marker/cursor.
   c. Range and bearing:
      Range and bearing is a method of release using a precomputed range and bearing for release. The "Alternate Bomb" checklist

will be used. Set precomputed range to release in the cursor range counters, position the azimuth marker to the release bearing and establish a track to the bomb release point. When the aiming point is coincident with the azimuth and range marker, release the weapon.

d. Visual:
The "Synchronous Bomb Run" checklist is used and the navigator selects VISUAL BOMB with the function select knob. The pilot establishes a track and depresses the release button when the pipper is coincident with the target. The time-to-go display on the NDU and BNDT then unblanks and will indicate the time in seconds to weapon release. Weapons bay doors should be opened manually to insure release of internal weapons.

MISSILE PROCEDURES.

1. Perform required checklists and procedures for strike/operational test launches and simulated launches as outlined in this section.
2. Coordinate with the pilot in completion of the checklist and use of the tone switch for RBS activity.
3. Items identified OTL are to be performed only for an operational test launch.

DESCENT, LANDING AND POSTFLIGHT PROCEDURES.

1. Accomplish the checklists and procedures as outlined in Section II.
2. Monitor penetration, low approach and missed approach procedures with particular emphasis on altitude restrictions.
3. Compute landing data as necessary.

OPERATING PROCEDURES. (NUCLEAR BOMBS/MISSILES)

SYSTEM (CAE) POWER APPLICATION.

Note

SRAM cooling must be supplied to missiles any time system power is on.

1. AGM-69A control and display panel:
   a. Select and monitor control knob—CAE.
   b. Power switch—ON. (Momentarily)
      On application of system power, momentary lighting of various AGM-69A control and display lamps may occur.
   c. PDU and COMP lamps—Out. (Within 15 seconds)
      PDU and COMP lamps will be out within 15 seconds, indicating the computer self-test and PDU end-around tests are complete. Reset avionic caution lamp (NDU) if required.
   d. SYS GO lamp—Lighted.
      SYS GO lamp will light when COMP and PDU lamps go out.
   e. SRAM PWR lamp—Lighted.
   f. MSL GO lamp—Lighted.
      Lighting of the MSL GO lamp indicates satisfactory completion of the missile prelaunch data computer missile status monitor test.
   g. Malfunction status lamps—Checked.
      The TEMP and MAST MAL lamps will light if missile cold plate temperature is not within limits. Reset the MAST MAL lamp by rotating the SEL & MON knob to missile position exhibiting a temperature no-go and actuating the MSL switch to CLR MAL. The time required for the TEMP lamp to clear will vary, depending on pretakeoff environment, missile complement, elapsed time from takeoff and SRAM cooling application, and aircraft mission profile.
2. AGM-69A lamp test—Accomplished.
   Perform lamp test of all AGM-69A lamps by depressing the malfunction and indicator lamp test button on the lighting control panel. Check that all lamps on the AGM-69A control and display panel and the SRAM indicator on the BNDT panel flash on and off at a one second rate. The NUCLEAR and SRAM caution lamps on the main caution lamp panel, and the SAFE, UNLOCK, and ARM lamps on the DCU-137/A panel will light. If lamp brightness requires adjustment, use the malfunction and indicator lamp dimming switch.

CAUTION

Do not depress the malfunction and indicator lamp test button while a target is displayed on the computer control unit. To do so may change class parameters of targets stored in the target table in the missile prelaunch data computer.

TARGET DATA VERIFICATION.

Note

- Verification must be accomplished prior to the HHCL.
- This procedure permits callout and display of missile prelaunch data computer stored target number. After examination for validity, the data may be corrected or replaced by new data using the "Target Data Change" procedures.
- Target data numbers 301 through 312 are assigned to preprogrammed targets 1 through 12. Target data number 313 (target 13) is assigned to the last fixpoint identifiication. The coordinates of the last fixpoint identification will, however, not be assigned to target data number 313 unless the RHAW/RDR mode switch has been actuated. Data number 300 permits display of the target currently being ranged upon.

1. Target data number (301 to 313)—Entered.
2. Data switch—DISP.
3. Target latitude, longitude and elevation—Verified.

Note

Class I, Class II, and Class III data can be verified with the address selector knob No. 1 in either the LAT, LONG, or ELEV position.

4. Class I, II and III data—Verified
   On the AGM-69A control and display panel, position the select and monitor knob to CLASS I and monitor the CLASS UP and CLASS DN lamps for response. Repeat for CLASS II and CLASS III. Return knob to ALL position.

Note

If additional target data verification is required, repeat procedure.

5. Data—Cleared.
   Verify data storage and data number display blank.

MISSILE PER TARGET VERIFICATION.

Note

Verification must be accomplished prior to the HHCL.

1. Data number 319—Entered.
2. Address selector knob No. 1—ELEV.
3. CLR pushbutton—Depressed. (Momentarily)
4. Missile per target data—Entered. (+3XX05)
   XX = Target 01 through 13.
5. Data switch—DISP.
6. Missiles per target—Verified.
   Check data storage display for the target number followed by the number of missiles per target (0 through 6); 3XXN.

Note

If additional missiles per target verification is required accomplish steps 3 through 6.

BOMBING EQUIPMENT CHECK.

1. Safety check—Nav reads:
   - **P** a. Nuclear caution lamp—Out.
   - **P** b. Nuclear consent switch—OFF, guard down, sealed.
   - c. Monitor and release knob—OFF.
   - d. Option select switch—OFF.
   - e. Bay door control switch—CLOSE.
2. Selected sequence point pushbutton—TARGET depressed.
   Verify that current steer point is a target.
3. **P** ISC—BOMB/NAV.
4. **P** Optical display system mode knob—CMD. (If required)
5. Stores control panel:
   - a. Release enable switch—INHIBIT.
   - b. Master switch—ON.
   - c. Delivery mode knob—BOMB. (RBS only)
   - d. Station select switch—Station selected.

WARNING

To prevent an inadvertent release, do not select any bomb/missile loaded station. (On a normal training mission do not select any store loaded station.)

6. Function selector knob—RADAR BOMB/MANUAL.
7. UHF #1—Unused channel. (RBS only)
8. Attack steering—Checked.
   Using tracking handle check for aircraft responses to left and right turns and that the aircraft returns to straight and level flight.
9. ATF and trail—Checked.
   Check manual or automatic ballistics.

P 10. Pilot calls TG:
- Driving.
- 60 seconds.
- 30 seconds.
- 10 seconds, RBS Tone—TONE 1. (If applicable)

B 11. Release indications—TG ZERO.
Release lamps light and tone breaks. (If applicable)

Note

The RBS tone may cut and release be indicated with as much as two seconds time to go.

12. Stores control panel:
   a. Station select switch—Deselect.
   b. Station selected lamp—Out.
   c. Master switch—As required.

Note

If missiles are powered-up, do not place master switch to OFF. To do so will power-down all missiles.

   d. Delivery mode knob—OFF.
13. Function select knob—As desired.

PENETRATION AIDS SELF TEST PROCEDURES.

Note

- For detailed description of the Penetration Aids System refer to T.O. 1F-111(B)A-1-3.
- Refer to T.O. 1F-111(B)A-1-3 for Scope and Threat Panel Display.
- Penetration Aids Self Test procedures are required only for alert acceptance, EWO/Contingency missions and when equipment reliability is in doubt.

1. RHAWS confidence checks:

Note

There are three confidence checks for the RHAWS; the lamp test, the display test, and the system test. The lamp test checks all RHAWS and IRRS lamps. The display test checks only the ability of the RHAW scope to display video. The system test checks all RHAWS components except the antennas.

a. Turn on:
   (1) Power/audio control knob—CW out of detent. (Approximately 2 minutes warm up required).
   (2) Scope filter—As desired.
   (3) Gate selector knob N.
   (4) Brightness knob—Full CW.
   Moving the knob CCW has the same effect as increasing memory.
   (5) Reticle intensity knob—As required.
   (6) Sensitivity control knob—Full CW.
   (7) Memory control knob—Full CCW.
b. Lamp test: (Check lamps only)
   (1) Test knob—Lamp.
   (2) All indicator lamps—Lighted.
      (a) Check cryo fail lamp.
      P (b) Check pilot's remote threat display.
c. Display test (Checks RHAW scope and TDP):
   (1) Test knob—Display.
   (2) Mode selector knob—IRT.
   Check that target appears in center of scope.
   (3) Mode selector knob—OMO.
   Check that 6 targets appear around the periphery of the scope. Signals will multiplex through the 3 bands.
d. System test:
   (1) Test knob—System.
   (2) Mode selector knob—H1.
   A target should appear on the scope. Center the target on the azimuth cursor and adjust to —3 degree elevation. Monitor the Threat Display Panel (TDP) for the appropriate warning lamps.
   (3) Mode selector knob—H2.
   A target should appear on the scope. Center the target on the azimuth cursor and adjust to —4 degree elevation. Monitor the TDP for the appropriate warning lamps.
   (4) Mode selector knob—H3.
   A target should appear on the scope. Center the target on the azimuth cursor and adjust to —5 degree elevation. Monitor the TDP for the appropriate warning lamps.
   (5) Mode selector knob—OMT-F.
   Bands 1, 2 and 3 targets with associated threat coding will be displayed at the antenna boresight positions. The threat panel lamps will light in conjunction with the associated targets on the RHAW scope. (See T.O. 1F-111(B)A-1-3 for RHAW scope displays.)

Note

Adjust the memory control knob for desired RHAW scope presentation. Minimum scope persistence settings are recommended.

(5A) ILS communications monitor knob — Fully counterclockwise. (After T.O. 1F-111-1074)

Note

After T.O. 1F-111-1074, the ILS monitor knob on the communications panel can be used to decrease the volume of the TFR aural command thereby insuring the detectability of the RHAWS audio signals.

(6) Power/audio control knob—Adjusted.
Insure that RHAWS audio signals and warning tone are detectable. Adjust the level of the warning tones with the RHAW interphone communications monitor knob (controls the level of both the warning tones and radar audio). Then adjust the level of the system tests radar tones with the RHAWS power/audio control knob (controls the level of the radar audio only).
(7) Mode selector knob—OMT-A.
Bands 1, 2 and 3 targets will be displayed at the antenna boresight position (±9 degrees).
(8) Mode selector knob—OMO.
Bands 1, 2 and 3 targets will be displayed at the designated positions.
(9) Test knob—OFF.

2. CMDS confidence check.

WARNING

- Do not place the CMDS arming switch to the ARM position during ground operation. To do so could result in inadvertent dispensing of explosive chaff or flares.
- With expendables loaded, do not perform the CMDS confidence check on the ground unless the CMDS safing plugs are installed, or inflight until over an authorized dispensing area or during EWO.

a. Arming switch—TEST.
b. TBC mode selector knob—MAN.
c. Aft AI lamp—Depressed.
Disp lamp will blink once.
d. TBC mode selector knob—OFF.
e. MLR mode selector knob—MAN.
f. IR TGT lamp—Depressed.
Disp and aft AI lamps will blink once.
g. MLR mode selector knob—OFF.
h. SPC mode selector knob—MAN.
i. Aft SAM lamp—Depressed.
Disp lamp will blink once.
j. SPC mode selector knob—OFF.
k. Arming switch—SAFE.

3. ECM confidence check:

WARNING

Prior to turning on equipment, advise all ground crew personnel to move away from the aircraft a minimum distance of 6 feet.

a. ECM control knobs (3)—REC.
(1) RCVR/PA indicator lamps (3) light and remain lighted until system warm-up time expires (approximately 3 minutes).
b. ECM control knobs (3)—ON.

Note

The ALQ-94 ECM system, operating in ON or TEST (prior to initiation of self-test), may create interference with other radars in the local area. This interference will be indicated by lighting of the XMIT threat indicator lamp for the appropriate band. Self-test should be initiated immediately after placing an ECM control knob to the TEST position.

c. ECM warm-up—Completed.
d. ECM low band control knob—TEST.
e. RCVR/PA LOW pushbutton indicator lamp—Depress and hold for 30 seconds, then release.
(1) RCVR/PA indicator lamps will light steady within one minute (blinking light indicates malfunction).
f. To re-initiate the self-test, rotate the ECM control knob to any other position (ON, REC or SPL) then back to TEST. Repeat step e.
g. Repeat steps d thru f for medium and high bands.

Note

In the event of a malfunction indication in REC or ON modes, the system can be reset by placing the control knob to OFF and returning the knob immediately (less than 1/8 second) to REC or ON. This will reset the system without necessitating a warmup delay. If the malfunction has cleared, the system will operate normally. If this procedure does not correct the malfunction, turn the system off for at least 3 minutes, then repeat the turn-on procedure.

4. IRRS confidence checks:

WARNING

With expendables loaded, do not perform the IRRS confidence check on the ground unless the CMDS safing plugs are installed. Do not perform items h through m during flight until over an authorized dispensing area or during EWO.

a. Function selector knob—OPR.
b. Cryogenic failure indicator lamp—Lighted.
c. Function selector knob—STBY.
d. RHAW mode selector knob—IRT.
e. Azimuth blanking control knob—AUTO.
f. Elevation blanking control knob—AUTO.
g. Ready/test indicator lamp—Lighted.
   If the ready/test indicator lamp does not light within 8 minutes, the system should be checked for proper servicing.
h. Function selector knob—OPR.
i. Ready/test indicator lamp—Out.
j. Test 1 button—Depress and hold.
   Ready/test lamp should light within 5 seconds. Only the scan lamp will be lighted.
k. Test 2 button—Depress and hold.
   Ready/test lamp should light within 5 seconds.
l. CMDS arming switch—TEST.
m. CMDS MLR mode selector knob—NORM.
n. Test 3 button—Depress and hold.
   The IR TGT lamp will light and the target will appear on the right side of the RHAW scope. The IR MLD lamp will light for approximately 5 seconds, the aft AI and IR display lamp will blink within 5 seconds, and the MLD warning tone will activate.
o. RHAW mode selector knob—IRS. (IRRS test 3 button depressed)
   Target on right side of RHAW scope should move vertically forming a line; this indicates proper IRRS scanner operation. The length of the line will vary with elevation blanking knob setting and aircraft altitude. (See T.O. 1F-111(B)A-1-3 for proper length.)
p. MLR mode selector knob—OFF.
q. CMDS arming switch—SAFE.
r. Function selector knob—As desired.
s. RHAW mode selector knob—OMO.

MISSILE ELECTRONIC POWER APPLICATION.

Note

- In order to allow missile environmental stabilization and IMU warm up, missile electronic power application is inhibited until 40 minutes have elapsed since system (CAE) power application.
- Missiles may be all simultaneously powered or powered individually through use of the select and monitor knob and the power switch on the AGM-69A control and display panel.
- All selected missiles must be powered within the two minute period prior to start of IMU coarse alignment. Missile electronic power application will be inhibited if any missile(s) is in coarse alignment. If additional missiles are desired to be powered after two minutes have elapsed, those missiles previously powered must be shut down and missile electronic power applied to all selected missiles within the two minute period prior to the start of IMU coarse alignment.
- A minimum of 90 seconds must have elapsed since missile electronic power shutdown before power can be applied to any missile. This 90 second inhibit prevents possible damage to the missile IMU caused by reapplication of power prior to adequate gyro spin-down.
- An emergency restart involving SIC 319 (+21) must be initiated within 5 minutes after missile shutdown. This 5 minutes includes the 90 seconds required for gyro spin-down.

1. Stores control panel:
   a. Master switch—ON.
   b. Delivery mode knob—SRAM MAN.
   c. Selector mode knob—NUC WPN.
2. AGM-69A control and display panel:
   a. Select and monitor knob—ALL or selected MSL POS.
      Position the select and monitor knob to ALL if it is desired to apply power to all missiles. If selective power application is required, position the knob to the appropriate MSL POS. Repeat substeps a through c for each missile as applicable.
   b. MSL GO and SYS GO lamps—Lighted.

Note

The TEMP lamp will blink if an attempt is made to apply missile electronic power without missile cooling.

c. Power switch—ON. (Momentarily)
   Positioning the power switch to ON supplies power to the missile electronics, provided no ordnance alarm, high temperature, or missile no-go exists.
d. SRAM PWR lamp—Lighted. (All powered missiles)
   Lighting of the SRAM PWR lamp at each individual missile position indicates power has been applied to missile electronics.
e. Select and monitor knob—ALL.
f. MSL NO GO lamp—Lighted. (Minimum of 16 minutes)
   Missile no-go status will be displayed in addition to missile go status for approximately 16 minutes. The missile no-go lamp will go out as a result of normal aircraft maneuvering or upon accomplishment of TAL procedure. A guidance TAL procedure may be accomplished after missile fine alignment has started (about 6 minutes after missile power on). The procedure may be performed whenever the MSL NO GO lamp lights in order to maintain the aligned state. Normal aircraft maneuvering should satisfy this requirement. Once the MSL NO GO lamp is off it should not light during the following 15 minute period. An alternate procedure is to allow the MSL NO GO lamp to remain lighted until 15 minutes prior to first missile launch, accomplishing the initial TAL procedure during the prelaunch check.

Note

A launch with degraded CEP may be possible as early as 8 minutes after missile electronic power application.

3. Stores control panel:
   a. Selector mode knob—CCW to OFF.
   b. Delivery mode knob—OFF.

Note

Rotating the selector mode knob through any jettison position with station(s) selected on the stores control panel will remove power from the missiles at those stations.

PENETRATION AIDS EQUIPMENT PRE-SET.

Note

This procedure will be accomplished prior to any Electronic Warfare activity. If "Penetration Aids Self-Test Procedures" are performed, "Penetration Aids Equipment Pre-Set" will be accomplished prior to any subsequent electronic warfare activity.

1. RHAWS:
   B a. RHAW communications monitor knob—As desired.
   Controls the warning tones and radar audio levels. Adjust (if not previously accomplished) by setting the desired warning tones level using RHAW lamp test or system test.
   a1. ILS communications monitor knob — Fully counterclockwise. (After T.O. 1F-111-1074)
   b. Power/audio knob—Adjusted.
   Controls only the radar audio. Adjust for the desired level on either actual radar signals or system test radar audio.
   c. Mode selector knobs—As desired.
   d. Scan indicator lamp—SCAN.
2. CMDS:
   a. Mode selector knobs (3)—As briefed.
   b. Arming switch—As briefed.

Note

Do not arm CMDS until after chaff/flares clearance has been obtained or the aircraft has entered the designated drop area or has reached a designated vulnerability point.

3. ECM mode knobs (3)—As briefed.
4. IRRS:
   a. Function selector knob—As required.
   b. Azimuth blanking control knob—AUTO.
   c. Elevation blanking control knob—AUTO.

FUEL TANK JETTISON PROCEDURES.

Selective jettison of fuel tanks must be accomplished in straight and level flight, with gear and flaps up, at an angle-of-attack less than 8 degrees. Jettison tanks singly, outboard to inboard with no more than one station asymmetry. Tanks must be empty, only residual fuel remaining. Stations 2 and 7 will be jettisoned prior to Prearming. If tanks on stations 3 and 6 are not jettisoned prior to the pre-arming point, they will be retained until in a nav mode outside a target complex. Refer to Stores Limitations, Section V, for tank release limits.

WARNING

If fuel tanks on stations 3 and 6 are retained through the target complex, failure to deselect bomb/missile loaded stations before jettisoning tanks will result in inadvertent release of missiles and pre-armed external bombs or missile power-down.

1. Stores control panel:
   a. Master switch—ON.
   b. All station select switches—Deselected.
      All stations must be deselected, station select lamp out, to prevent jettisoning weapons or missile power-down.
   c. Selector mode knob—STA JETT.
   d. Delivery mode knob—AUX.
   e. Station selector switch (tank to be jettisoned)—Selected.
      Depress the station selector switch corresponding to the pylon station carrying the tank to be jettisoned.
   f. Station selected lamp—Lighted.
      Station selected lamp for external fuel tank station to be jettisoned should be lighted.
   g. Release enable switch—RELEASE ENABLE.

B 2. Weapon release button—Depressed.

Note

Repeat step 1.e., f. and step 2 to jettison additional tank(s).

N 3. Stores control panel:
   a. Release enable switch—INHIBIT.
   b. Delivery mode knob—OFF.
   c. Selector mode knob—NUC WPN.

Note

If above checks are used to jettison tanks from stations 3 and 6 after departing the target complex, pre-arming of retained weapons must be reaccomplished by performing steps 5a and 7 of "prearming."

PREDESCENT AND DESCENT (LOW ALTITUDE TACTICAL OPERATION). (PRIOR TO T.O. 1F-111-996)

If TFR is not to be performed, only the ♦ steps must be accomplished. Auto/manual TF letdown will be made from cruise mach, throttles and airspeed as required. *Non-TF descents will be made at cruise mach until* intercepting the indicated airspeed that corresponds to the desired low level mach. Adjust to low level mach after level off.

B 1. TFR operational check—Completed.

♦**B** 2. Fuel panel—Checked.

♦**P** 3. Engine inlet anti-icing—Climatic.

♦**B** 4. Altimeters—Reset. (If required)

♦ 5. IFF—Set.

♦**P** 6. AMI and AVVI command markers and ODS indicated airspeed—Set to desired airspeed and altitude.

♦**P** 7. Radar altimeter—Set as briefed.

8. TFR switches—Set.
   a. Range selector knob—E position.
   b. Ride control knob—As desired.
   c. Volume control knob—As desired.
   d. Terrain clearance knob—1000 feet.

B8A. ILS communications monitor knob—As desired. (After T.O. 1F-111-1074)

P 9. Radar altimeter bypass switch—BYPASS.

B10. L and R TFR channel mode selector knobs—TF.

P11. Reference or ATF not engaged lamp (as applicable)—Lighted.

P12. Pitch steering mode selector switch—TF.
   a. ADI and ODS pitch steering bars—Indicate dive.
   b. Aural command—Dive.
   c. TF warning and channel fail lamps—OFF.
   d. E scope—Checked.
      Check self test pulse and zero command line.

WARNING

If the self-test pulse is absent, do not fly TF under night or IFR conditions.

B13. Fly-up check—Complete.
   a. Autopilot release lever—Hold depressed. (Prior to T.O. 1F-111(B)A-593)
   b. Autopilot release/PCSS lever—Depress and hold to first detent. (After T.O. 1F-111(B)A-593)
   c. Radar altimeter control knob—Depress and hold.
      (1) Bypass switch—Return to normal.
      (2) Off warning flag—Out of view.
      (3) Indicator pointer—95 ($\pm$12) feet.
      (4) TFR failure warning and channel fail caution lamps—Lighted.
      (5) ADI and ODS pitch steering bars—Full fly-up command.
      (6) Aural command—Full climb. (If above 5000 feet AGL)

WARNING

If the aural command is not a climb, it indicates the TFR is receiving or interpreting the altitude incorrectly. TF should not be performed if switching LARA or TFR channels does not correct the command.

d. Radar altimeter control knob—Release.

e. Autopilot release lever or autopilot release/ PCSS lever (as applicable)—Release.

(1) Fly up maneuver—Initiated.

f. Autopilot release lever—Depressed (Prior to T.O. 1F-111(B)A-593)

g. Autopilot release/PCSS lever—Depress and hold to first detent. (After T.O. 1F-111(B)A-593)

h. Radar altitude bypass switch—BYPASS.

i. Autopilot release lever or autopilot release/ PCSS lever (as applicable)—Release.

P14. Auto TF switch—AUTO. (If desired)

Leave the auto TF switch off for Oil Burner Entry. The reference or ATF not engaged lamp (as applicable) will be lighted during the time the auto TF switch is off. If autopilot sub-modes are being used i.e., HDG/ NAV, monitor the aircraft closely to ensure the aircraft is following steering commands.

Note

- The pitch trim function of the stick trim button is deactivated when auto TF is engaged. A slight pitch transient may be felt when auto TF is engaged if the parallel pitch trim actuator is not at take off trim due to normal system tolerances.
- If a fly-up is commanded due to rain during the letdown, the pilot should depress the autopilot release lever prior to T.O. 1F-111(B)A-593 or depress to the first detent the autopilot release/PCSS lever after T.O. 1F-111(B)A-593, establish a 10 degree dive angle, and continue a manual letdown until 1000 feet above the MEA. At this time, he should decrease the dive angle to 2 degrees and level off at the desired MEA. The letdown to 1000 feet, and subsequently lower settings, can be resumed as the rain return disappears from the E-scope.

♦**P**15. Wing sweep—As required.

The wing sweep for auto TF letdown will normally be that computed for low altitude operation. Avoid high angles-of-attack with aft wing sweeps prior to initiating descent. In cases of high altitude and/or low airspeed, wing sweep should be delayed until descent has been initiated.

P16. ADI and ODS pitch steering bars—Centered. (Auto TF letdown)

♦ 17. Altitude calls—Accomplished.

The navigator will announce the altitude calls when crossing 15,000, 10,000 and 5,000 feet MSL. He will also notify the pilot 1000 feet above initial level off.

P18. At 5000 feet above the terrain: (If applicable)

a. Radar altimeter bypass switch—NORMAL.

b. Dive angle increase to 12 degrees.

♦ 19. Altitude calibration—Completed.

If terrain conditions permit an accurate calibration.

♦**B**20. Altimeters crosschecked—Accomplished.

Crosscheck AVVI, standby altimeter and radar altimeter.

♦**B**21. Level off—Monitored.

During auto and manual TF letdown a climb command should be indicated on the ADI/ ODS command bars at approximately 2000 feet AGL and aircraft rotation toward level flight should begin no later than 1600 feet AGL.

♦**B**22. Helmet visors—Lowered. (As practicable)

Note

Whenever practical the flight crew shall lower helmet visors for protection against bird strikes which might cause windshield failure when at low altitude.

♦**P**23. Wing sweep—Set.

P24. Auto TF switch—AUTO. (As required)

P25. 1000 foot check:

a. Terrain clearance—Checked. (900 to 1200 feet)

Use the radar altimeter to check the terrain clearance.

b. E scope display—Checked.

Check video positioning relative to command line.

26. 83% fly-up—Checked.

This check should be performed over level terrain or water if possible.

a. Radar altimeter index pointer—Set 830 feet.

b. Clearance plane—Set 500 feet.

c. Radar altitude low warning lamp—Lighted, passing 830 feet.

Aircraft should level within limits of 500 foot setting. (440-650 feet)

d. Fly-up Initiated.

Set 1000 feet clearance plane after pausing momentarily at 750 foot setting.

(1) TF failure warning lamp—Lighted until aircraft passes through 830 feet absolute.

(2) ADI/ODS—Indicate fly-up.
The pitch steering bars on the ADI/ODS will indicate a fly-up until the TF fail clears, then indicate normally.

(3) Aural command—Full climb.

(4) Radar altitude low warning lamp—Out at 830 feet.

(5) Autopilot release lever—Depress and hold, then release. (Prior to T.O. 1F-111(B)A-593)
Depress lever and hold while leveling aircraft at 1000 feet, then release.

(6) Autopilot release/PCSS lever—Depress and hold to first detent, then release. (After T.O. 1F-111(B)A-593)
Depress lever and hold while leveling aircraft at 1000 feet, then release.

(7) Aircraft levels at 1000 feet.

(8) Radar altimeter channel select switch—Opposite channel.

(9) Repeat substeps b through d.

WARNING

If the 83% fly-up capability is not operational in a radar altimeter channel, do not use that channel for TF operation.

27. Terrain clearance knob—Set as briefed.
28. Radar altimeter—Reset to 83 percent of clearance plane.
29. L or R TFR channel mode selector knob SIT or GM.

WARNING

Airspeed should be held to mach 0.85 or less when the 500 foot position, WX mode, is selected. If this airspeed is exceeded, the TFR will not anticipate the terrain early enough to provide a command to prevent terrain impact.

Note

TF fly-up fail is caused by one of several conditions. Refer to "TF Fly-up Causes," this section.

TFR INFLIGHT OPERATIONAL CHECK. (After T.O. 1F-111-996)

This check is required only if the TFR ground check was not performed. This check must be accomplished at an altitude above 5000 feet AGL to obtain specified indications.

1. Wing sweep—As required.
2. Radar altimeter index pointer—Set 200 feet.
3. Terrain clearance knob—Set 800 feet.
4. Ride control—MED.
5. TFR channel mode selector knobs — L TF, R SIT.
   a. TFR channel fail caution lamps—Lighted.
   b. Reference not engaged caution lamp — Lighted.
   c. TF fly-up off caution lamp—Lighted.
   d. TF failure warning lamp—Lighted.
   e. Radar altitude low warning lamp—Out.
6. ISC pitch steering mode switch—TF.
7. Radar altimeter bypass switch—BYPASS.
8. Radar altimeter control knob — Depress and hold.
   a. Radar altimeter bypass switch — Returns to NORMAL.
   b. Radar altimeter—300 (±15) feet.
   c. TF failure warning lamp—Out.
   d. TFR channel fail caution lamps—Out.
   e. Radar altitude low warning lamp—Out.
   f. TF fly-up off caution lamp—Out.
   g. Pitch steering bars and aural command indicate a slight dive command (if level flight).
9. Auto TF switch—AUTO TF.
   Aircraft establishes a slight dive.
10. Terrain clearance knob—Set 300 feet.
    a. Pitch steering bars and aural command — Approximately nulled (if level flight).
    b. Aircraft establishes level flight.
11. Terrain clearance knob—Set 400 feet.
    a. Aircraft response—Fly-up.
    b. TF failure warning lamp—Lighted.
    c. TFR channel fail caution lamp—Lighted, for channel in TF mode.
    d. Radar altitude low warning lamp—Lighted.
    e. Pitch steering bars and aural command indicate maximum climb command.
12. Radar altimeter control knob—Released.
13. Autopilot release lever — Depress and hold. (Prior to T.O. 1F-111(B)A-593)

14. Autopilot release/PCSS lever—Depress and hold to first detent. (After T.O. 1F-111(B)A-593)
15. Radar altimeter bypass switch—BYPASS.
16. Autopilot release lever or autopilot release/ PCSS lever (as applicable)—Release.
17. Auto TF switch—OFF.
18. E scope—Checked.
    Check self-test pulse and zero command line.

WARNING

If the self-test pulse is absent, do not fly TF under night or IFR conditions.

19. Repeat steps 3 thru 18 with TFR and radar altimeter channels reversed.
20. TFR L and R channel mode selector knobs — TF.

PREDESCENT AND DESCENT (LOW ALTITUDE TACTICAL OPERATION). (AFTER T.O. 1F-111-996)

If TFR is not to be performed, only the ♦ steps must be accomplished. Auto/manual TF letdown will be made from cruise mach, throttles and airspeed as required. Non-TF descents will be made at cruise mach until intercepting the indicated airspeed that corresponds to the desired low level mach. Adjust to low level mach after level off.

B 1. TFR operational check — Completed. (Ground or inflight)
♦**B** 2. Fuel panel—Checked.
♦**P** 3. Engine inlet anti-icing—Climatic.
♦**B** 4. Altimeters—Reset. (If required)
♦ 5. IFF—Set.
♦**P** 6. AMI and AVVI command markers and ODS indicated airspeed—Set to desired airspeed and altitude.
♦**P** 7. Radar altimeter—Set as briefed.
8. TFR switches—Set.
    a. Range selector knob—E position.
    b. Ride control knob—As desired.
    c. Volume control knob—As desired.
    d. Terrain clearance knob—1000 feet.
B 9. ILS communications monitor knob—As desired. (After T.O. 1F-111-1074)
P 10. Radar altimeter bypass switch—BYPASS.
B 11. L and R TFR channel mode selector knobs — TF.
P 12. Reference or ATF not engaged lamp (as applicable)—Lighted.
P 13. Pitch steering mode selector switch—TF.
    a. ADI and ODS pitch steering bars—Indicate dive.
    b. Aural command—Dive.
    c. TF failure warning and channel fail lamps—Out.
    d. E scope—Checked.
       Check self-test pulse and zero command line.

WARNING

If the self-test pulse is absent, do not fly TF under night or IFR conditions.

B 14. Fly-up check—Complete.

Note

This check is optional if the inflight operational check has been accomplished.

    a. Terrain clearance knob—Set 400 feet.
    b. Autopilot release lever — Hold depressed. (Prior to T.O. 1F-111(B)A-593)
    c. Autopilot release/PCSS lever — Depress and hold to first detent. (After T.O. 1F-111(B)A-593)
    d. Radar altimeter control knob—Depress and hold.
       (1) Bypass switch—Return to normal.
       (2) Off warning flag—Out of view.
       (3) Indicator pointer—300 (±15) feet.
       (4) TFR failure warning and channel fail caution lamps—Lighted.
       (5) ADI and ODS pitch steering bars—Full fly-up command.
       (6) Aural command—Full climb.
    e. Autopilot release lever or autopilot release/ PCSS lever (as applicable)—Release.
       (1) Fly-up maneuver—Initiated.
    f. Autopilot release lever — Depressed. (Prior to T.O. 1F-111(B)A-593)
    g. Autopilot release/PCSS lever—Depress and hold to first detent. (After T.O. 1F-111(B)A-593)
    h. Radar altimeter control knob—Release.
    i. Radar altitude bypass switch—BYPASS.
    j. Autopilot release lever or autopilot release/ PCSS lever (as applicable)—Release.
    k. Terrain clearance knob—Set 1000 feet.
P 15. Auto TF switch—AUTO. (If desired)
    Leave the auto TF switch off for Oil Burner Entry. The reference or ATF not engaged lamp (as applicable) will be lighted during the time the auto TF switch is off. If auto-

pilot sub-modes are being used i.e., HDG/NAV, monitor the aircraft closely to ensure the aircraft is following steering commands.

Note

- The pitch trim function of the stick trim button is deactivated when auto TF is engaged. A slight pitch transient may be felt when auto TF is engaged if the parallel pitch trim actuator is not at take off trim due to normal system tolerances.
- If a fly-up is commanded due to rain during the letdown, the pilot should depress the autopilot release lever prior to T.O. 1F-111(B)A-593 or depress to the first detent the autopilot release/PCSS lever after T.O. 1F-111(B)A-593, establish a 10 degree dive angle, and continue a manual letdown until 1000 feet above the MEA. At this time, he should decrease the dive angle to 2 degrees and level off at the desired MEA. The letdown to 1000 feet, and subsequently lower settings, can be resumed as the rain return disappears from the E-scope.

♦P16. Wing sweep—As required.
The wing sweep for auto TF letdown will normally be that computed for low altitude operation. Avoid high angles-of-attack with aft wing sweeps prior to initiating descent. In cases of high altitude and/or low airspeed, wing sweep should be delayed until descent has been initiated.

P17. ADI and ODS pitch steering bars — Centered. (Auto TF letdown)

♦ 18. Altitude calls—Accomplished.
The navigator will announce the altitude calls when crossing 15,000, 10,000 and 5,000 feet MSL. He will also notify the pilot 1000 feet above initial level off.

P19. At 5000 feet above the terrain:
(If applicable)
a. Radar altimeter bypass switch—NORMAL.
b. Dive angle increase to 12 degrees.

♦ 20. *Altitude calibration—Completed.*
If terrain conditions permit an accurate calibration.

♦B21. Altimeters crosschecked—Accomplished.
Crosscheck AVVI, standby altimeter and radar altimeter.

♦B22. Level off—Monitored.
During auto and manual TF letdown a climb command should be indicated on the ADI/ODS command bars at approximately 2000 feet AGL and aircraft rotation toward level flight should begin no later than 1600 feet AGL.

♦B23. Helmet visors—Lowered. (As practicable)

Note

Whenever practical the flight crew shall lower helmet visors for protection against bird strikes which might cause windshield failure when at low altitude.

♦P24. Wing sweep—Set.

P25. Auto TF switch—AUTO. (As required)

P26. 1000 foot check:
a. Terrain clearance — Checked. (900 to 1200 feet)
Use the radar altimeter to check the terrain clearance.
b. E scope display—Checked.
Check video positioning relative to command line.

27. 83% fly-up—Checked. (Optional)
This check should be performed over level terrain or water if possible.
a. Radar altimeter index pointer—Set 830 feet.

b. Clearance plane—Set 500 feet.

c. Radar altitude low warning lamp—Lighted, passing 830 feet.
Aircraft should level within limits of 500 foot setting. (440-650 feet)

d. Fly-up—Initiated.
Set 1000 feet clearance plane after pausing momentarily at 750 foot setting.

(1) TF failure warning lamp—Lighted until aircraft passes through 830 feet absolute.

(2) ADI/ODS—Indicate fly-up.
The pitch steering bars on the ADI/ODS will indicate a fly-up until the TF fail clears, then indicate normally.

(3) Aural command—Full climb.

(4) Radar altitude low warning lamp—Out at 830 feet.

(5) Autopilot release lever — Depress and hold, then release. (Prior to T.O. 1F-111(B)A-593)
Depress lever and hold while leveling aircraft at 1000 feet, then release.

(6) Autopilot release/PCSS lever—Depress and hold to first detent, then release. (After T.O. 1F-111(B)A-593)
Depress lever and hold while leveling aircraft at 1000 feet, then release.

(7) Aircraft levels at 1000 feet.

(8) Radar altimeter channel selector switch—Opposite channel.

(9) Repeat substeps b through d.

WARNING

If the 83% fly-up capability is not operational in a radar altimeter channel, do not use that channel for TF operation.

28. Terrain clearance knob—Set as briefed.
29. Radar altimeter—Reset to 83 percent of clearance plane.
30. L or R TFR channel mode selector knob SIT or GM.

WARNING

Airspeed should be held to mach 0.85 or less when the 500 foot position, WX mode, is selected. If this airspeed is exceeded, the TFR will not anticipate the terrain early enough to provide a command to prevent terrain impact.

PREARMING.

WARNING

- This procedure will not be accomplished for a simulated SRAM launch. Proceed to "Missile Preparation for Simulated Launch," this section.
- With SRAM loaded aircraft, do not perform steps 2, 3 and 6 if RBS bombing activity is to be performed. 73-5

Note

- Perform the following not earlier than 15 minutes prior to the HHCL ("H" Hour Control Line) or not earlier than 15 minutes prior to descent for a low altitude mission, whichever is reached first, and only after receipt of a valid "GO" code.
- Prearming of all weapons will be completed not later than the first IP for bombs and prior to prelaunch for missiles, and only after jettison of fuel tanks that will not be retained through the first target complex.

1. Stores control panel:
   a. Delivery mode knob—OFF.
   b. Master switch—ON.
   c. Selector mode knob—NUC WPN.
2. DCU-137/A control panel:
   a. Option select switch—SAFE.
   b. Control lever—S ARM.
   Break the safety seal and position the control lever to S ARM.
   c. Option select switch—GRD RET.

Note

Normally, GRD RET will be the first option used for all releases. If varying options are desired, the bombs will be pre-armed individually by placing the DCU-137/A option select switch to the desired option and selecting the applicable station.

   d. Class III command override switch—As required.
   e. Class III indicator—Checked.

P 3. Nuclear consent switch—ARM & REL.

4. Stores control panel: (RBS only)
   a. Selector mode knob—STA JETT.
   b. Station select lamps—Out.
      If any station select lamp is lighted, deselect station.
   c. Test button—Depressed; station select lamp lighted at all loaded stations.
   d. Selector mode knob—NUC WPN.
   e. Test button—Depressed. (Bombs)
      Check station select lamps lighted for all bomb loaded stations, out for all others.
   f. Delivery mode knob—SRAM MAN. (Missile)
   g. Test button—Depressed. (Missile)
      Check station select lamps lighted for all missile loaded stations, out for all others.
   h. Delivery mode knob—OFF. (Missile)

WARNING

On normal training sorties with external fuel tanks loaded, if any abnormal station select lamp indications are noted, place the master switch off, perform "Abort Procedures" and do not attempt any practice bombing activity.

15-7

5. Stores control panel: As Req'd
   a. Release enable switch—~~INHIBIT (RBS only) or RELEASE ENABLE (EWO only).~~

WARNING

New WARNING 15-7

~~To prevent inadvertent stores release, the release enable switch will not be placed to RELEASE ENABLE for normal training sorties.~~

   b. Station select switches—Selected.
      Bombs will be selected two at a time if identical options are desired.

WARNING

On normal training sorties, do not select any store loaded station.

CAUTION

Simultaneous prearming of more than three bombs could overload the arming circuits and result in incomplete operation of bomb prearming switches.

Note

All SRAM loaded stations may be selected simultaneously.

   c. Station selected lamps—Lighted. (Bombs only)
      Station select lamps will not light at missile stations until a SRAM position is selected using the delivery mode knob.

6. DCU-137/A control panel:
   a. Monitor and release knob—As required.
   b. Burst option monitor lamp — Lighted. (Bombs only)
      The burst option monitor lamp agreeing with the position of the option select switch should light.
   c. Arm monitor lamp—Lighted.
   d. Unlock monitor lamp—Lighted.
   e. Monitor and release knob — Additional station(s).
      Check monitor lamps as indicated in b, c and d above.
7. Additional bombs/missiles — Prearm. (2 at a time, as applicable)
   a. Monitor and release knob — Station being prearmed.
   b. Station select switches—Selected.
   c. Station selected lamps — Lighted. (Bombs only)
   d. Monitor lamps—Checked.
   e. Monitor and release knob—Other station.
   f. Monitor lamps—Checked.
8. Monitor and release knob—Station to be released/monitored.

WARNING

External bombs/missiles will not be released until after all fuel tanks are jettisoned.

MISSILE PREPARATION FOR SIMULATED LAUNCH.

WARNING

If nuclear consent (unlock and prearm) is provided, the missile prelaunch data computer will ignore the position of the train switch. Critical launch functions will therefore not be bypassed and missile launch will occur.

Note

Simulated launch will be inhibited if either unlock or prearm has been commanded.

P 1. Nuclear consent switch—OFF, guard down.
2. AGM-69A control and display panel:
   a. Select and monitor knob—ALL.
   b. Train switch—TRAIN.
3. Stores control panel:
   a. Release enable switch—INHIBIT.
   b. Master switch—ON.
   c. Selector mode knob—STA JETT.
   d. Station select lamp—Out.
      If any station select lamp is lighted, deselect station.
   e. Test button—Depressed, station select lamps lighted at all loaded stations.
   f. Delivery mode knob—SRAM MAN.
   g. Selector mode knob—NUC WPN.
   h. Test button—Depressed, station select lamps lighted at missile simulated loaded stations; all others out.
4. DCU-137/A control panel:
   a. Control lever—OMS, sealed.
   b. Option select switch—MON.
   c. Monitor lamps (each SRAM loaded station) —Checked.
      SAFE lamp lighted, all other lamps are out.

Note

The class III command override switch may be repositioned any time prior to entry into launch countdown.

   d. Class III command override switch—As required.
      If a change in class III setting is required, position the class III command override switch to UP or DOWN. Positioning the class III command override switch determines class III setting for all missiles.
   e. Class III indicator—Checked. (If required)
      If the class III command override switch was used, rotate the monitor and release knob through missile positions. The class III indicator will reflect the command.
   f. Monitor and release knob—OFF.
   g. Option select switch—OFF.

PRE BOMB/PRE LAUNCH.

- FOR BOMBS—Accomplish the following checklist prior to reaching each IP. In the event an IP is not designated, complete this checklist in sufficient time to accomplish the bomb run.
- FOR MISSILES—Start the following checklist at least 15 minutes prior to each launch point.

1. Altitude calibration—Completed. (Bombs)

B 2. Altimeters—Set as required.
3. UHF No. 1—Set as briefed. (RBS only)

P 4. ODS mode select knob—CMD. (If required)

P 5. Bombing timer—Set. (If applicable)

P 6. Bombing timer power selector knob—ON. (If applicable)

7. Manual ballistics—Set.
   Set manual ballistics from data computed on bombing data form.
8. Penetration aids equipment—On and set.
9. Bomb run timing/heading/altitude—Verified.
   Advise the pilot of the time and altitude to the first release and the magnetic course/heading, time and altitude between multiple releases.
10. Alternate release data—Determined.
    Determine TG from the applicable timing point using best known ground speed and bombing altitude. Refer to "Emergency Bombing Procedures" in T.O. 1F-111(B)A-25-3, or adjusted precomputed data as required.
11. Bay door control switch—As required.
12. High altitude launch mach number—Enter. (If required)
    If launch will be accomplished above 30,000 feet altitude, determine true mach number at which the first launch will be initiated and accomplish the procedure. Subsequent high altitude launches at the same mach number require no additional SIC 13 inputs. However, a SIC 13 input is required for high altitude launches each time the launch mach number changes from the preceding launch. Allowable tolerance on launch mach number is ± 0.02 for winds equal to or greater than 120 knots and ± 0.05 for winds less than 120 knots.

B 13. OTL carrier power application—Accomplished. (If required)
If mission is an operational test launch, accomplish "OTL Carrier Power Application" prior to "OTL Battery Power Application" and at a time determined by range control.

14. Ranging—Monitored.
- Data number—Entered.
Enter data number 300 to 312, as desired.
- Address selector knob No. 1—ELEV.
- Data switch—DISP.
If data number 300 is entered, the CCU data storage windows will display zeros until a target is in range. At that time, the windows will display the target data number and the number of missiles programmed for the target.

15. Altitude calibration—Accomplish. (Within 15 minutes of launch)
For maximum system accuracy, altitude calibration should be accomplished at launch conditions.

Note

Missile launch may be accomplished without a TAL procedure, but accuracy will be degraded.

P 16. TAL procedure—Completed. (Between 15 and 2 minutes prior to launch)
Accomplish TAL procedures within 15 minutes of launch to attain maximum system accuracy. Maneuvers accomplished less than two minutes prior to launch may not improve missile guidance azimuth alignment.

17. Present position—Updated. (Between 7 and 2 minutes prior to launch)
Update present position within seven minutes of launch to attain maximum system accuracy, and no later than two minutes prior to launch.

18. OTL carrier aircraft present position—Recorded. (If required)
If it is required that the carrier position at the time of present position update be recorded as part of the mission scoring data, accomplish the following procedure.
a. Data number 319—Entered.
b. Address selector knob No. 1—ELEV.
c. Clear pushbutton — Depressed. (Momentarily)
d. SIC number (+6)—Entered.

19. AGM-69A malfunction and status indicator lamps—Checked.
SYS GO, SRAM PWR, MSL GO lamps lighted, all others off except for an OTL launch, when OTL CARR PWR lamp and C/D RCVR ready lamps should also be lighted.

20. Radar altimeter—Checked.
If the radar altimeter is inoperative, Class I down-launch is inhibited. Proceed with command guidance.

B 21. OTL battery power application — Accomplish. (If required)
If mission is an Operational Test Launch, accomplish battery power application approximately four minutes prior to launch.

SYNCHRONOUS BOMB RUN.

Accomplish this checklist after sequencing to the target.

Note

For a bomb run abort, immediately position the delivery mode knob to OFF. If no further releases are to be attempted, proceed to "Abort Procedures," this section.

P 1. ISC switch BOMB/NAV.
2. Select sequence point pushbutton—TGT.
3. Sequence number set wheels—Set to next tgt or destination.
4. Monitor and release knob — Station to be released.
5. Station selected lamps—Lighted.
Check that applicable station select lamps are lighted for selected bomb stations and out for all others.
6. Stores control panel test button — Depressed, station select lamps lighted at bomb simulated loaded stations; all others out (RBS only).

WARNING

On normal training sorties with external fuel tanks loaded, if any abnormal station select lamp indications are noted, place the master switch OFF, perform "Abort Procedures" and do not attempt any practice bombing activity.

7. Function select knob — RADAR BOMB/VISUAL BOMB.

Note

If utilizing a pseudo target, do not complete the following items until past the pseudo target.

8. Bay door control switch—As required.

Note

- When using AUX (auxiliary) bay door power, manual operation of the doors is required. AUTO (automatic) door opening may inhibit bomb release due to excessive door opening time.
- For manual door opening, position the bay door control switch to OPEN approximately 60 seconds prior to release.
- For internal release with the delivery mode knob in AUX the bay door switch must be OPEN.

9. Delivery mode knob—BOMB.

WARNING

The delivery mode knob must be left in the OFF position until passing a pseudo target to preclude an inadvertent release.

10. Bomb away:
    B a. Lamps — Checked.
    The pilot's and navigator's bomb release lamps will light when a release signal is present. This release signal will normally be present for approximately 3 seconds prior to T.O. 1F-111(B)A-651. After T.O. 1F-111(B)A-651, the release signal will be present for approximately 1 second and the navigator's bomb release lamp will remain lighted for an additional 2 seconds after the release signal is removed. In either configuration, the station selected and stores present lamp and all DCU-137/A lamps will go out when the bomb is released.

WARNING

- Do not operate any of the bombing system controls, except as noted below, when a release signal is present as indicated by the pilot's bomb release lamp. Operation of the master switch, station select switches, monitor and release knob, delivery mode knob, or selector mode knob during presence of a release signal (normally 3 seconds prior to T.O. 1F-111(B)A-651; 1 second after T.O. 1F-111-(B)A-651) may result in inadvertent store release.
- On normal training sorties, if the pilot's bomb release lamp remains lighted for an indefinite period of time (approximately 5 seconds or more prior to T.O. 1F-111(B)A-651; 3 seconds or more after T.O. 1F-111-(B)A-651) place the delivery mode knob OFF, selector mode knob OFF, and master switch OFF, in that sequence, perform "Abort Procedures," this section, and do not attempt any practice bombing activity.

Note

If there was no automatic release at TG zero, place the delivery mode knob to AUX, the bay door control switch to OPEN (internal release) and depress the weapon release button.

Multiple Release:

11. Sequence number set wheels—Set to next target or destination.
12. Monitor and release knob — Station to be released.
13. Bay door control switch—As required.
14. Delivery mode knob—As required.
15. Bomb away:
    B a. Lamps — Checked.
    The pilot's and navigator's bomb release lamps will light when a release signal is present. This release signal will normally be present for approximately 3 seconds prior to T.O. 1F-111(B)A-651. After

T.O. 1F-111(B)A-651, the release signal will be present for approximately 1 second and the navigator's bomb release lamp will remain lighted for an additional 2 seconds after the release signal is removed. In either configuration, the station selected and stores present lamp and all DCU-137/A lamps will go out when the bomb is released.

WARNING

- Do not operate any of the bombing system controls, except as noted below, when a release signal is present as indicated by the pilot's bomb release lamp. Operation of the master switch, station select switches, monitor and release knob, delivery mode knob, or selector mode knob during presence of a release signal (normally 3 seconds prior to T.O. 1F-111(B)A-651; 1 second after T.O. 1F-111-(B)A-651) may result in inadvertent store release.
- On normal training sorties, if the pilot's bomb release lamp remains lighted for an indefinite period of time (approximately 5 seconds or more prior to T.O. 1F-111(B)A-651; 3 seconds or more after T.O. 1F-111-(B)A-651) place the delivery mode knob OFF, selector mode knob OFF, and master switch OFF, in that sequence, perform "Abort Procedures," this section, and do not attempt any practice bombing activity.

Note

- If there was no automatic release at TG zero, place the delivery mode knob to AUX, the bay door control switch to OPEN (internal release) and depress the weapon release button.
- Repeat steps 11 through 15 for additional releases.

ALTERNATE BOMB RUN.

This checklist should commence after passing last destination prior to target.

Note

For a bomb abort, immediately position the delivery mode knob to OFF. If no further releases are to be attempted, proceed to "Abort Procedures," this section.

P 1. ODS mode select knob — As required.
2. Monitor and release knob — Station to be released.
3. Station select lamps—Lighted.
   Check that applicable station select lamps are lighted for selected bomb stations and out for all others.
4. Stores control panel test button — Depressed, station select lamps lighted at bomb simulated loaded stations; all others out (RBS only).

WARNING

On normal training sorties with external fuel tanks loaded, if any abnormal station select lamp indications are noted, place the master switch OFF, perform "Abort Procedures," and do not attempt any practice bombing activity.

5. Bay door control switch—OPEN. (If required)

Note

With normal system operation it takes 2.5 seconds for doors to open. If using auxiliary system, position the bay door control switch to open approximately 60 seconds prior to release.

6. Delivery mode knob—AUX.
7. Bomb away—Release accomplished.
   a. Weapon release button — Depressed.
   B b. Lamps — Checked.
   When the weapon release button is depressed, weapon release is commanded to the station and the pilot's weapon release lamp is lighted. The release lamp will remain lighted as long as the weapon release button is held depressed. The station selected and stores present lamp and all DCU-137/A lamps will go out when the bomb is released.

WARNING

- Do not operate any of the bombing system controls, except as noted below, when a release signal is present as indicated by the pilot's bomb release lamp. Operation of the master switch, station select switches, monitor and release knob, delivery mode knob, or selector mode knob during presence of a release signal (weapon release button depressed) may result in inadvertent store release.
- On normal training sorties, if the pilot's bomb release lamp remains lighted after the weapon release button is released, place the delivery mode knob OFF, selector mode knob OFF, and master switch OFF, in that sequence, perform "Abort Procedures," this section, and do not attempt any practice bombing activity.

Multiple Release:

8. Monitor and release knob — Station to be released.
9. Bay door control switch—OPEN. (If required)
10. Delivery mode knob—AUX.
11. Bomb away—Release accomplished.
    a. Weapon release button—Depressed.
    B b. Lamps—Checked.
    When the weapon release button is depressed, weapon release is commanded to the station and the pilot's weapon release lamp is lighted. The release lamp will remain lighted as long as the weapon release button is held depressed. The station selected and stores present lamp and all DCU-137/A lamps will go out when the bomb is released.

WARNING

- Do not operate any of the bombing system controls, except as noted below, when a release signal is present as indicated by the pilot's bomb release lamp. Operation of the master switch, station select switches, monitor and release knob, delivery mode knob, or selector mode knob during presence of a release signal (weapon release button depressed) may result in inadvertent store release.
- On normal training sorties, if the pilot's bomb release lamp remains lighted after the weapon release button is released, place the delivery mode knob OFF, selector mode knob OFF, and master switch OFF, in that sequence, perform "Abort Procedures," this section, and do not attempt any practice bombing activity.

Note

Repeat steps 8 through 11 for additional releases.

AUTOMATIC LAUNCH—STRIKE/OTL.

WARNING

- If for any reason it is necessary to withhold launch, immediately position selector mode knob to B/C, delivery mode knob to OFF and reposition the selector mode knob to NUC WPN. Rotating the delivery mode knob thru the SRAM AUTO position with the selector mode knob in NUC WPN and a SAFE IN RANGE lamp on will initiate a missile countdown sequence. If no further launches are to be attempted or if this is an OTL launch, proceed to "Abort Procedures".
- External missile will not be launched/jettisoned with external fuel tanks installed or with weapons outboard of missile. Only weapons bay missiles will be selected and launch accomplished in SRAM manual mode.

CAUTION

Launching a missile without sufficient battery warmup time may result in rupture of the missile battery case or degraded missile performance after launch. Refer to figure 4-2 for missile battery warmup requirements.

Note

- With SRAM automatic delivery mode selected, launch will occur automatically against targets stored in the missile prelaunch data computer when the SAFE IN RANGE lamp lights steady. The missile selected for automatic launch is computer controlled.

Note

- The missile system can receive fixpoint identification data from the DCC. The latitude and longitude available from the DCC are those of the last fixpoint identification accomplished. When entered into the AGM-69A target table by use of the RHAW/RDR mode switch, in the automatic mode, it becomes available for active ranging in addition to preprogrammed targets.
- If a no-go missile exists or occurs during launch, and launching the next missile in automatic sequence would result in an asymmetrical loading of more than one missile, the automatic launch sequence will be inhibited. To continue the automatic launch sequence either of the following two procedures must be accomplished: (1) manual launch of the no-go missile, if no-go can be overridden with manual launch, (2) jettison of no-go missile.

1. Select and monitor knob—ALL.
2. Delivery mode knob—SRAM AUTO.
3. Safe in range lamp—Lighted.

   A steady indication means a target is in range, the aircraft is within level flight limits, and the missile prelaunch data computer is processing a launch. A blinking indication means launch is being inhibited and that aircraft altitude, attitude or acceleration is resulting in out-of-limits condition for launch. If a missile has entered a launch countdown and the blinking indication cannot be corrected within 45 seconds the missile will become no-go.

P 4. SRAM indicator on BNDT—On.

WARNING

Aircraft should be maintained straight and level or within the limits specified in "Stores Limitations", Section V, for a period of five seconds before to five seconds after missile launch. This is to assure proper missile battery fill and to prevent the possibility of aircraft/missile collision.

5. SRAM PWR lamp—Blinking.

   SRAM PWR lamp will blink during countdown after the missile prelaunch data computer issues the activate missile battery command.

6. Bay door position indicator—OPEN. (Weapons bay launch)

   Doors will open approximately 2.5 seconds into the countdown.

Note

If launch is from weapons bay and doors do not open, position the bay door control switch to OPEN and if required, bay door auxiliary switch to AUX. Weapons bay doors must be open within 45 seconds or missile will be declared no-go.

7. Missile launch lamps—Check.
   a. Weapon present and station select lamps—Out. (For launched missiles)
   b. Bomb release lamp (NDU)—Lighted.

      The navigator's bomb release lamp will light approximately three seconds after launch and remain lighted for three seconds.

WARNING

- Do not operate any of the bombing system controls, except as noted below, when a release signal is present as indicated by the pilot's bomb release lamp. Operation of the master switch, station select switches, monitor and release knob, delivery mode knob, or selector mode knob during presence of a release signal may result in inadvertent store release.
- On normal training sorties, if the pilot's bomb release lamp remains lighted for an indefinite period of time (approximately 5 seconds or more prior to T.O. 1F-111(B)A-651; 3 seconds or more after T.O. 1F-111(B) A-651) place the delivery mode knob OFF, selector mode knob OFF, and master switch OFF, in that sequence, perform "Abort Procedures," this section, and do not attempt any practice bombing/missile launch activity.

8. DCU-137/A control panel (launched station):
   a. Monitor and release knob—Launched station.
   b. Status lamps—Out.
   c. Class III indicator—UP.
   d. Monitor and release knob—Next missile to be monitored.
9. Bay doors—Closed.

MANUAL LAUNCH—STRIKE/OTL.

WARNING

- If for any reason it is necessary to withhold launch, immediately position the selector mode knob to B/C, delivery mode knob to OFF, check REL CMD lamp is out, then position selector mode knob back to NUC WPN. Rotating the delivery mode knob thru the SRAM AUTO position with the selector mode knob in NUC WPN and a SAFE IN RANGE lamp on will initiate a missile countdown sequence. If no further launches are to be attempted or if this is an OTL launch, proceed to "Abort Procedures".
- External missile will not be launched with external fuel tanks installed or weapons outboard of missile.
- External missile selection should be in an outboard-to-inboard sequence maintaining symmetrical aircraft loading (within one missile).

CAUTION

Launching a missile without sufficient battery warmup time may result in rupture of the missile battery case or degraded missile performance after launch. Refer to figure 4-2 for missile battery warmup requirements.

Note

- Certain no-go conditions are overridable by launching missiles in the SRAM manual delivery mode, overridable no-go's are: SAF NO GO, ALT (launch inertially to override), and TEMP.
- The missile system can receive fixpoint identification data from the DCC. The latitude and longitude available from the DCC are those of the last fixpoint identification accomplished. When entered into the AGM-69A target table by use of the RHAW/RDR mode switch it becomes available for active ranging.
- If a Class 1 down altimeter flight is desired, do not select a missile with an inoperative radar receiver-transmitter. This selection will result in a low level inertial missile flight.

1. Select and monitor knob—ALL or selected MSL POS.
   Position select and monitor knob to ALL for computer missile selection. For individual missile selection position knob to desired MSL POS and observe release sequence specified above.

Note

Manual launch may be accomplished in two manners: (1) A specific target data number (301 to 313) may be called up for display and a launch can be initiated as soon as the target is in-range. In this case the SAFE IN RANGE lamp will not light for any other targets while the addressed target is displayed. (2) With no targets displayed, enter data number 300. The target data number displayed will identify the primary or alternate target which is being ranged on depending on the ranging priority selected.

2. Delivery mode knob—SRAM MAN.

Note

The highest priority target for ranging is the manually designated target. The missile prelaunch data computer will range on this target to the exclusion of all others.

3. Target data number 301 to 313 option (if applicable):
   Enter target data number on computer control unit if launch against a specific target is desired.
   a. Target data number (301 to 313)—Entered.
   b. Data switch—DISP.
   c. Address selector knob No. 1—LAT, LONG or ELEV. (As desired)
4. Data number 300 option (if applicable):
   Enter data number 300 on computer control unit if launch against target being ranged-on is desired.
   a. Data number 300—Entered.
   b. Data switch—DISP.
   c. Address selector knob No. 1—ELEV.
   d. In-range target—Identified.
      Following lighting of the SAFE IN RANGE lamp, the DATA STORAGE display will display the number of the in-range target (301 through 306 or 307 through 312, depending on ranging priority). Followed by a number representing the number of missiles programmed for the target.

5. Safe in range lamp—Lighted.
   A steady indication means a target is in-range, the aircraft is within level flight limits, and the missile prelaunch data computer is ready to process a launch countdown. A blinking indication means launch countdown processing is being inhibited and that aircraft altitude, attitude or acceleration is resulting in out-of-limits condition for launch. If a missile has entered a launch countdown and the blinking indication cannot be corrected within 45 seconds the missile will become no-go.

P 6. SRAM indicator on BNDT—On.

WARNING

Aircraft should be maintained straight and level or within the limits specified in "Stores Limitations," Section V, for a period of five seconds before to five seconds after missile launch. This is to assure proper missile battery fill and to prevent the possibility of aircraft/missile collision.

7. Weapon release button — Depressed. (Momentarily)
8. AGM-69A control and display panel:
   a. REL CMD lamp—Lighted.
      REL CMD lamp will light indicating receipt of a manual launch command.
   b. SRAM PWR lamp—Blinking.
      SRAM PWR lamp will blink during countdown after the missile prelaunch data computer issues the activate missile battery command.
9. Bay door position indicator—OPEN. (Weapons bay launch)
   Doors will open approximately 2.5 seconds into the countdown.

Note

If launch is from weapons bay and doors do not open, position the bay door control switch to OPEN and if required, bay door auxiliary switch to AUX. Weapons bay doors must be open within 45 seconds or missile will be declared no-go.

10. Missile launch lamps—Checked.
    a. Weapon present and station select lamps—Out.
    b. Bomb release lamp (NDU)—Lighted.
       The navigator's bomb release lamp will light approximately three seconds after launch and remain lighted for three seconds.

WARNING

- Do not operate any of the bombing system controls, except as noted below, when a release signal is present as indicated by the pilot's bomb release lamp. Operation of the master switch, station select switches, monitor and release knob, delivery mode knob, or selector mode knob during presence of a release signal may result in inadvertent store release.
- On normal training sorties, if the pilot's bomb release lamp remains lighted for an indefinite period of time (approximately 5 seconds or more prior to T.O. 1F-111(B)A-651; 3 seconds or more after T.O. 1F-111(B)A-651) place the delivery mode knob OFF, selector mode knob OFF, and master switch OFF, in that sequence, perform "Abort Procedures," this section, and do not attempt any practice bombing/missile launch activity.

11. DCU-137/A control panel (launched station):
    a. Monitor and release knob—Launched station.
    b. Status lamps—Out.
    c. Class III indicator—UP.
    d. Monitor and release knob—Next missile to be monitored.
12. Bay doors—Closed.

SIMULATED AUTOMATIC LAUNCH.

Note

- If for any reason it is necessary to withhold a simulated launch, immediately position the selector mode knob to B/C, the delivery mode knob to OFF then place selector mode knob back to NUC WPN. Rotating the delivery mode knob thru the SRAM AUTO position with the selector mode knob in NUC WPN and a SAFE IN RANGE lamp on will initiate a simulated missile countdown sequence. If no further simulated launches are to be attempted proceed to "Abort Procedures".

Note

- With SRAM automatic delivery mode selected, simulated launch will occur automatically against targets stored in the missile prelaunch data computer when the SAFE IN RANGE lamp lights steady. The missile selected for simulated automatic launch is computer controlled.
- The missiles system can receive fixpoint identification data from the DCC. The latitude and longitude available from the DCC are those of the last fixpoint identification accomplished. When entered into the AGM-69A target table by use of the RHAW/RDR mode switch it becomes available for active ranging *in addition to all preprogrammed targets in* the automatic mode.
- Mission scoring data will be provided for a maximum of six simulated launches.

1. Select and monitor knob—ALL.
2. Stores control panel:
   a. Delivery mode knob—SRAM AUTO.
3. Safe in range lamp—Lighted.

   A steady indication means a target is in-range, the aircraft is in level flight, and the missile prelaunch data computer is processing a simulated launch. A blinking indication means simulated launch is being inhibited and that aircraft altitude, attitude, or acceleration is resulting in out-of-limits condition for simulated launch. If a missile has entered a simulated launch countdown and the blinking indication cannot be corrected within 45 seconds the missile will become no-go.

P 4. SRAM indicator on BNDT—On.

5. SRAM PWR lamp—Blinking.

   SRAM PWR lamp will blink during countdown after the missile prelaunch data computer issues the activate missile battery command.
6. Simulated missile launch—Checked.
   a. Bomb release lamp (NDU)—Lighted.

      The navigator's bomb release lamp will light approximately three seconds after simulated launch and remain lighted for three seconds.

WARNING

- Do not operate any of the bombing system controls, except as noted below, when a release signal is present as indicated by the pilot's bomb release lamp. Operation of the master switch, station select switches, monitor and release knob, delivery mode knob, or selector mode knob during presence of a release signal may result in inadvertent store release.
- On normal training sorties, if the pilot's bomb release lamp remains lighted for an indefinite period of time (approximately 5 seconds or more prior to T.O. 1F-111(B)A-651; 3 seconds or more after T.O. 1F-111(B)A-651) place the delivery mode knob OFF, selector mode knob OFF, and master switch OFF, in that sequence, perform "Abort Procedures," this section, and do not attempt any practice bombing/missile launch activity.

7. AGM-69A malfunction and status lamps—Checked.

   Position the select and monitor knob to the simulated launched missile position. Check status lamps on the AGM-69A control and display panel for simulated launched missile. SRAM PWR lamp will go out; MSL GO, and SYS GO lamps will remain lighted.

Note

Repeated simulated launch of a single missile is possible provided missile electronic power is reapplied following each launch, and a missile per target is assigned. After missile electronic power is applied, proceed to "Missile Preparation For Simulated Launch."

SIMULATED MANUAL LAUNCH.

Note

- If for any reason it is necessary to withhold a simulated launch, immediately postion the selector mode knob to B/C, delivery mode knob to OFF and check that REL CMD indicator lamp is out. Position the selector mode knob back to NUC WPN. Rotating the delivery mode knob thru the SRAM AUTO position with the selector mode knob in NUC WPN and a SAFE IN RANGE lamp lighted will initiate a simulated missile countdown sequence. If no further simulated launches are to be attempted, proceed to "Abort Procedures".
- The missile system can receive fixpoint identification data from the DCC. The latitude and longitude available from the DCC are those of the last fixpoint identification accomplished. When entered into the AGM-69A target table by use of the RHAW/RDR mode switch it becomes available for active ranging.
- Missile symmetry is not required for simulated manual launch.
- Mission scoring data will be provided for a maximum of six simulated launches.

1. Select and monitor knob—ALL or selected MSL POS.

   Position select and monitor knob to ALL for computer missile selection. For individual missile selection, position knob to desired MSL POS.

Note

A simulated manual launch may be accomplished in two manners: (1) A specific target data number (301 to 313) may be called up for display and a simulated launch can be initiated as soon as the target is in-range. In this case the SAFE IN RANGE lamp will not light for any other targets while the addressed target is displayed. (2) With no targets displayed, enter data number 300. The target data number displayed will identify the primary or alternate target which is being ranged on depending on the ranging priority selected.

2. Delivery mode knob—SRAM MAN.

Note

The highest priority target for ranging is the manually designated target. The missile prelaunch data computer will range on this target to the exclusion of all others.

3. Target data number 301 to 313 option (if applicable):

   Enter target data number on computer control unit if simulated launch against a specific target is desired.

   a. Target data number (301 to 313)—Entered.
   b. Data switch—DISP.
   c. Address selector knob No. 1—LAT, LONG or ELEV. (As desired)

4. Data number 300 option (if applicable):

   Enter data number 300 on computer control unit if simulated launch against target being ranged-on is desired.

   a. Data number 300—Entered.
   b. Data switch—DISP.
   c. Address selector knob No. 1—ELEV.
   d. In-range target—Identified.

      Following lighting of the SAFE IN RANGE lamp, the data storage display will display the number of the in-range target (301 through 306 or 307 through 312, depending on ranging priority), followed by a number representing the number of missiles programmed for the target.

5. Safe in range lamp—Lighted.

   A steady indication means a target is in-range, aircraft is in level flight limits, and the missile prelaunch data computer is ready to process a simulated launch countdown. A blinking indication means launch countdown processing will be inhibited and that aircraft altitude, attitude or acceleration is resulting in

out-of-limits condition for simulated launch. If a missile has entered a simulated launch countdown and the blinking indication cannot be corrected within 45 seconds the missile will become no-go.

P 6. SRAM indicator on BNDT—On.

7. Weapon release button — Depressed. (Momentarily)

8. AGM-69A control and display panel:

   a. REL CMD lamp—Lighted.

      REL CMD lamp will light indicating receipt of a manual launch command.

   b. SRAM PWR lamp—Blinking.

      SRAM PWR lamp will blink during countdown after the missile prelaunch data computer issues the activate missile battery command.

9. Simulated missile launch—Checked.

   a. Bomb release lamp (NDU)—Lighted.

      The navigator's bomb release lamp will light approximately three seconds after simulated launch and remain lighted for three seconds.

WARNING

- Do not operate any of the bombing system controls, except as noted below, when a release signal is present as indicated by the pilot's bomb release lamp. Operation of the master switch, station select switches, monitor and release knob, delivery mode knob, or selector mode knob during presence of a release signal may result in inadvertent store release.
- On normal training sorties, if the pilot's bomb release lamp remains lighted for an indefinite period of time (approximately 5 seconds or more prior to T.O. 1F-111(B)A-651; 3 seconds or more after T.O. 1F-111(B)A-651) place the delivery mode knob OFF, selector mode knob OFF, and master switch OFF, in that sequence, perform "Abort Procedures," this section, and do not attempt any practice bombing/missile launch activity.

10. AGM-69A malfunction and status indicator lamps—Checked.

    Check lamps on the AGM-69A control and display panel for simulated launched missile. SRAM PWR lamp and REL CMD lamp will go out; MSL GO, and SYS GO lamps will remain lighted.

Note

Repeated simulated launch of a single missile is possible provided missile electronic power is reapplied following each launch, and a missile per target is assigned. After missile electronics power is reapplied, proceed to "Missile Preparation for Simulated Launch."

POST RELEASE/POST LAUNCH.

Accomplish the following checks after each single release/launch or after release/launch of the last weapon of a multiple release/launch.

1. Bay door control switch—CLOSE. (If applicable)
2. Delivery mode knob—OFF/SRAM MAN. (As required)
3. Function select knob—NAV.

Note

- (EWO only) After all external weapons have been released/launched, pylons may be jettisoned to reduce drag. Use the selective store jettison (non-nuclear) checklist, Section III.
- After all bombs/missiles have been released/launched, perform the following steps.

4. Release enable switch—INHIBIT.

P 5. Nuclear consent switch—OFF.

6. Monitor and release knob—OFF.
7. Option select switch—OFF.
8. Master switch—As required.

   The master switch must remain ON if a missile simulated launch has been accomplished and missile power-down is not desired.

9. Selector mode knob—OFF.
10. Delivery mode knob—OFF.
11. Bombing timer mode selector knob—OFF.

Note

If the aircraft is returning to destination with bombs/missiles aboard, perform "Abort Procedures," this section.

ABORT PROCEDURES.

Note

Accomplish steps as applicable; the sequence will remain the same in all situations.

1. Release enable switch—INHIBIT.
2. Selector mode knob—B/C.
3. Delivery mode knob—OFF.
4. Selector mode knob—NUC WPN.
5. Stores station select switches—Deselected.
   Check that all corresponding station select lamps are off.

P 6. Nuclear consent switch—OFF, guard down.

7. AGM-69A control and display OTL panel:
   a. Battery power applied:
      (1) Select and monitor knob—Selected missile position.
      (2) OTL switch—BAT.
      (3) Power switch—OFF. (Momentarily)
      (4) OTL BAT POWER lamp—Out.
      (5) Additional NTIK missile—Battery power shutdown. (If required)
          If required, accomplish substeps (1) through (4) for second NTIK missile.
      (6) OTL switch—N.

Note

- If additional OTL launch activity is anticipated, proceed to "Prearming" following the completion of computer ranging on the aborted target (safe in range lamp out).
- Accomplish remaining steps if no further launch activity is to be attempted or if all missiles have been launched.

   b. Carrier power applied:
      (1) Select and monitor knob—Selected missile position.
      (2) OTL switch—CARR.
      (3) Power switch—OFF. (Momentarily)
      (4) OTL CARR POWER lamp—Out.
      (5) Additional NTIK missile—Carrier power shutdown. (If required)
          If required, accomplish substeps (1) through (4) for second NTIK missile.
      (6) OTL switch—N.
8. DCU-137/A control panel:
   a. Option select switch—SAFE.
   b. Control lever—OMS.
   c. Monitor lamps—Checked.
   Sequentially rotate the monitor and release knob through individual SRAM stations. At each position check SAFE lamp is lighted, all other lamps out, where missiles are present. All monitor lamps out, where missiles are not present.
   d. Monitor and release knob—OFF.
   e. Option select switch—OFF.
   f. Class III command override switch—OFF.
9. AGM-69A control and display panel:
   a. Select and monitor knob—ALL or selected MSL POS.
      Use selected missile position for specific missile shutdown.
   b. Power switch—OFF. (Momentarily)

CAUTION

Check that SRAM PWR lamp goes out following actuation of power switch, indicating successful missile electronic power shutdown. If power shutdown cannot be accomplished, do not remove SRAM cooling. Positioning the SRAM cooling switch to OFF with missile electronic power applied can result in missile overheat damage.

   c. SRAM PWR lamp—Out.
   d. Additional missile shutdown—Repeat substeps a thru c.
   e. Select and monitor knob—CAE.
   f. Power switch—OFF. (Momentarily)
   g. All malfunction and status indicator lamps—Out.
10. Stores control panel:
   a. Weapon present lamps—Checked.
      Weapon present lamps will remain lighted for missiles present.
   b. Master switch—OFF.
   c. Selector mode knob—OFF.
11. SRAM cooling switch—As required.
    If all missiles have been released, position SRAM cooling switch to OFF. If missiles are present, maintain cooling to missiles with electronic power applied.

Note

(EWO only) After all external missiles have been launched, pylons may be jettisoned to reduce drag. Use the "Selective Stores Jettison (Non-Nuclear)" checklist, Section III.

DESCENT, LANDING AND POSTFLIGHT PROCEDURES.

1. Accomplish the checklists and procedures as outlined in Section II.

HF COMMUNICATION SYSTEM OPERATION.

WARNING

Ensure that no personnel or equipment remain in the vicinity of the vertical fin or dorsal antenna sections while the HF radio is transmitting. Be sure that no fuel, oil, or oxygen carts are connected to the aircraft while operating the HF radio. Refer to Section II for danger areas.

Note

- If ground operation of the HF system is required, electromagnetic radiation may produce excessive harmonic distortion in the external power monitor, resulting in the power monitor rejecting ground power. Should this occur the external power switch should be selected to OFF and then OVRD.
- Electromagnetic interference from HF radio transmission, on some frequencies, may cause a fly-up maneuver when operating the TFR in the TF mode. This interference may also cause degradation of the TFR scope displays. If HF radio use is essential and interference is noted when operating in the TF mode, the terrain should be cleared visually or, if this is not possible, the aircraft climbed to the minimum enroute altitude.

1. Transmitter selector knob—HF.
2. HF monitor knob—On.
3. Mode selector knob—Desired mode.
4. Volume control—Adjusted.
   Adjust volume control to obtain audio balance between HF and UHF radios.
5. RF gain control knob—Maximum clockwise.
6. Squelch control knob—Maximum clockwise.
7. Desired frequency—Set.
8. Microphone switch—TRANS.
   After a frequency change, a 1 kilohertz tone will be heard when the microphone switch is first placed to TRANS. This indicates that the amplifier power supply unit and antenna coupler are tuning. When the tone ceases, the tuning cycle is complete and a sidetone will be heard when transmitting. Lack of sidetone indicates coupler mistune or an incorrect adjustment of the volume control knob.
9. RF gain control knob—Adjusted.
   Establish contact and then adjust RF GAIN control knob to obtain optimum signal to noise ratio.

Note

If receiver operation is unsatisfactory, rotate the volume control, RF gain control, and squelch control knobs to the maximum clockwise position.

GROUND ALIGNMENT. (ALTERNATE)

Alignment to Stored Heading.

Note

- For an accurate stored heading the INS must have undergone an accurate gyrocompass alignment and the aircraft must not have been moved since the system was turned off.
- Placing the function select knob to NAV momentarily after the gyrocompass alignment will improve the subsequent stored heading alignment.

1. INS ground align knob—STRD HDG.
2. General navigation computer switch—GNC.
3. Weapons delivery computer switch—WDC.
4. Function select knob—GND ALIGN.
   Check that the INS heat lamp comes on immediately after entering the ground align mode. The align lamp should light steady within 1½ minutes after going to the align mode.
5. Align lamp—Flashing.
   This completes the alignment mode.

Alignment to Stored Magnetic Variation.

Note

- For an accurate stored magnetic variation alignment the INS must have undergone an accurate gyrocompass aligament (not a two axis trim) and the aircraft, if moved, must be returned to within 2.5 degrees of original heading, and the magnetic variation must have remained essentially unchanged.
- Placing the function select knob to NAV momentarily after the gyrocompass alignment will improve subsequent magnetic variation alignment.

1. INS ground align knob—MAG HDG.
2. General navigation computer switch—GNC.
3. Weapons delivery computer switch—WDC.
4. Function select knob—GND ALIGN.
   Check that INS heat lamp lights immediately after entering the ground align mode. The align lamp should light steady within 1½ minutes after going to the align mode.

5. Align lamp—Flashing.
   This completes the alignment mode.

TWO AXIS TRIM ALIGNMENT PROCEDURE.

1. INS ground align knob—TRIM.
2. General navigation computer switch—GNC.
3. Weapons delivery computer switch—WDC.
4. Function select knob—GND ALIGN.
   Check that INS heat lamp lights immediately after entering the ground align mode. The align lamp should light steady within 1½ minutes after going to the align mode. The align light will flash for 20 seconds after completion of the first gyrocompass alignment. If NAV mode is not selected during this 20 second interval, the stable element will be slewed 90 degrees and the second gyrocompass alignment will be initiated. The align lamp will remain out during this alignment. Upon completion of the second gyrocompass alignment (approximately 9 minutes) the align lamp will begin flashing.
5. Data switch—ENTRY.
   Enter coordinates and mag var of the aircraft location behind data number 000.
6. INS reset button—Depress.
   If the align lamp is lighted, it will go out for approximately 90 seconds and then come on.
7. Align lamp—Flashing.
   This completes alignment mode.

DCC RECOVERY AND INS INFLIGHT ALIGNMENT.

1. TAS mode recovery:
   a. NAV mode select pushbutton—TAS selected. (All other modes deselected)
   b. INS ground align knob—OFF.
      Insure that the TAS advisory light only is lighted.
   c. Flight instrument reference switch—AUX.
      Manual steering is required until the system is recovered.
   d. Heading cross-check—Accomplished.
      Insure AFRS heading is slaved and synchronized, cross-check headings with the standby magnetic compass.
   e. Function select knob—GND ALIGN.
      The present position displays will revert to the coordinates in data number 00.
   f. Data entry—Accomplished and verified.
      (1) Data switch—ENTRY.
      (2) Data number—Enter 00.
      (3) Latitude/longitude — Enter to nearest 0.01.
          Enter the coordinates of the planned point to be overflown.
      (4) MAG VAR—Enter to nearest 0.1.
      (5) Wind SPD and DIR—Entered and verified on NDU.
   g. Function select knob—NAV.
      When the aircraft is over the selected point, place the function select knob to NAV and verify the present position is driving.
   h. Present position—Updated as required.
      Use cursor drift as a guide to determine system accuracy. In the TAS mode, frequent present position corrections must be accomplished following a change in heading, altitude, or wind. Special emphasis must be given to manually entered winds, MAG VAR, and multiple present position corrections on the same fixpoint.

Note

If acceptable navigation data cannot be maintained, turn off the GNC and manually enter the best known wind and MAG VAR.

2. Doppler mode recovery:
   a. NAV mode select pushbutton—D selected. (All other modes deselected)
   b. INS ground align knob—OFF.
   c. Flight instrument reference switch—AUX.
      Manual steering is required until the system is recovered.
   d. Heading cross-check—Accomplished.
      Insure AFRS heading is slaved and synchronized, cross-check headings with the standby magnetic compass.
   e. Function select knob—GND ALIGN.
      The present position displays will revert to the coordinates in data number 00.
   f. Data entry—Accomplished and verified.
      (1) Data switch—ENTRY.
      (2) Data number—Enter 00.
      (3) Latitude/longitude — Enter to nearest 0.01.
          Enter the coordinates of the planned point to be overflown.
      (4) MAG VAR—Enter to nearest 0.1.
      (5) Wind SPD and DIR—Checked on NDU.
          Insure DCO lamp out, D advisory lamp lighted. If doppler information is invalid, use the TAS mode recovery in the previous step.
   g. Function select knob—NAV.
      When the aircraft is over the selected point, place the function select knob to NAV and verify the present position is driving.

h. Present position—Update as required.
   Use cursor drift as a guide to determine system accuracy. In the doppler mode, frequent present position corrections must be accomplished. Special emphasis must be given to manually entered MAG VAR.

Note

If acceptable navigation data cannot be maintained, turn the GNC off, check heading and MAG VAR. If navigation data is still unacceptable, deselect doppler, select TAS, and re-enter wind and MAG VAR.

3. If INS inflight alignment is desired:
   The INS will not align inflight without the GNC or WDC on and operational.
   a. INS ground align knob — OFF, for 30 seconds.
   b. I nav mode pushbutton — Selected.
   c. INS ground align knob — G/C. (Remain straight and level for 45 seconds)
   d. INS align lamp—Lighted.
      The align lamp will not light unless the INS ground align knob has been recycled.
   e. Primary attitude/heading caution lamps — Out. (When the I nav mode lamp lights)
      If the primary attitude caution lamp is lighted, check that the flight instrument reference selector is in primary.
   f. Present position — Updated as necessary.
   g. INS align lamp—Out. (When alignment is complete)
      It is not necessary to maintain straight and level flight after the first 45 seconds; however, doppler attitude limits (28 degrees roll and 18 degrees pitch) should be observed and turns may improve the alignment. Alignment time will vary greatly depending on flight path, the velocity reference being used, the number of updates performed and the time between each.
4. Nav mode select pushbuttons—As desired.

DATA ENTRY.

1. Data switch—ENTRY.
2. Address select switch—Set.
   Position the address selector knob to the type of data to be entered. If the address select switch number 2 must be used, position the address select switch number 1 to the (Arrow) → position.
3. Clear pushbutton—Depress.
4. Data entry pushbuttons—Enter data.
   Check that the proper data is displayed on the data storage/data number display.
5. Enter pushbutton—Depress.
   Check that the data storage/data number display goes blank and the entered data reappears.

Note

Data entry cannot be performed if the ALT CAL pushbutton was depressed when the DCC was powered up.

SEQUENCE NUMBER ENTRY.

1. Sequence number set wheels—Set.
2. Selected sequence point pushbutton—Depressed.
3. Data switch—SEQ.
4. Clear pushbutton—Depress.
5. Data entry pushbuttons—Enter data number.
   Verify the data number is correct; if not depress the CLR pushbutton and re-enter the data.
6. Enter pushbutton—Depress.
   The data number will go blank momentarily and the data number will reappear.
7. Data number counter—Check for correct data number.
8. Data storage counter—Check for correct sequence number.

SEQUENCE NUMBER VERIFICATION.

1. Sequence number set wheels—Set.
2. Manual sequence and display pushbutton—Depress.
3. Selected sequence point pushbutton—Depressed.
   Verify correct sequence point display on selected sequence point counters.

WEAPONS LOCATION AND ID VERIFICATION.

1. Data number—Entered.
   Enter the data number for the first weapon location.
2. Address select number 1—Arrow position →.
3. Address select number 2—WPN LOC and ID.
4. Data switch—DISP.
5. Data storage display—Verified.
   Check that the seven digit number in the data storage window agrees with the SAC Form 482. Repeat steps 1 through 5 for each weapon.

DATA POINT VERIFICATION.

1. Data switch—ENTRY.
2. Address select number 1—DATA NO.
3. Clear pushbutton—Depress.
4. Data entry pushbuttons—Enter data number.
   Observe correct data number on Data No. counter.
5. Enter pushbutton—Depress.
   Observe data No. counter blanks and data number reappears.
6. Data switch—DISP.
7. Address select number 1—LAT.
   Verify that correct latitude is displayed on the data storage counter.
8. Address select number 1—LONG.
   Verify that correct longitude is displayed on the data storage counter.
9. Address select number 1—ELEV.
   Verify that correct elevation is displayed on the data storage counter.

SEQUENCE INTERRUPT.

1. Selected sequence point pushbutton—Depress.
2. Sequence number setwheels—Set as desired.
3. Sequence number select pushbutton—Depress.
   Verify the sequence number and coordinates are displayed correctly.

PRESENT POSITION CORRECTION—RADAR

1. Function select knob—NAV or MANUAL.
2. Fix mode selector knob — RADAR FXPT or RADAR DEST.
3. Present position correction switch—IN.

Note

Cursor movement is not possible with present position switch out.

4. Radar mode selector knob—GND AUTO or GND VEL.
   Place cursors over selected point with the tracking control handle.
5. Fix mode switch—OFF.
   When the fix mode switch is rotated to OFF, corrections for present position update are sent to the DCC.
6. Present position correction switch—OUT.

PRESENT POSITION CORRECTION—VISUAL OVERFLY.

1. Function select knob—NAV or MANUAL.
2. Fix mode selector knob—VISUAL OVERFLY.
3. Destination or fixpoint pushbutton—Depressed.
   If a target is utilized, the function select knob must be in NAV and the destination pushbutton must be depressed.
4. Sequence interrupt—Accomplished.
   Interrupt to a programmed destination, fixpoint, or target. Manual entry of destination or fixpoint coordinate data may be accomplished in lieu of the sequence interrupt to a planned point. Do not depress manual sequence and display.
5. Wind and mag var—Entered. (As required)
6. EVF pushbutton—Depressed at time of overfly.
   Only the first actuation of the EVF switch will be accepted by the computer complex. If the visual overfly was not accepted, complete item 7 and reaccomplish entire procedure above.
7. Fix mode selector knob—OFF.

PRESENT POSITION CORRECTION—VISUAL AUTOMATIC.

1. Select sequence point pushbutton — Depress DEST or FXPT as desired.
2. Fix mode selector knob—VISUAL AUTO.
3. ODS mode select knob—CMD.
4. Aiming reticle cage lever—Uncaged.
5. EVF pushbutton—Depress at time of ODS reticle coincidence on selected DEST/FXPT.
6. Fix mode selector knob—OFF.

PRESENT POSITION CORRECTION—INS AUTONOMOUS.

1. Data switch—ENTRY.
2. Address select number 1—LAT, LONG.
3. Data entry pushbuttons—Enter latitude and longitude.
   Once the data entry button is depressed, only MAG VAR is displayed in the data storage window.
4. INS reset button—Depressed. (When over fixpoint)
   The coordinates will appear in the NDU present position display when the INS reset button is depressed.

FIXPOINT IDENTIFICATION—RADAR.

1. Function select knob—NAV.
2. Selected sequence point pushbutton—FXPT ID.
3. Fix mode selector knob — RADAR FXPT or RADAR DEST.
4. Radar mode selector knob—GND AUTO or GND VEL.

5. Attack radar tracking control handle — Place cursors over selected point.
6. Fix mode selector knob—OFF.
7. Fixpoint identification selected sequence number—Recorded.

FIXPOINT IDENTIFICATION—VISUAL OVERFLY.

1. Function select knob—NAV.
2. Selected sequence point pushbutton—FXPT ID.
3. Fix mode selector knob—VISUAL OVERFLY.
4. EVF pushbutton—Depress at time of overfly
5. Fix mode selector knob—OFF.
6. Fixpoint identification selected sequence number—Recorded.

FIXPOINT IDENTIFICATION—VISUAL AUTOMATIC.

1. Function select knob—NAV.
2. Selected sequence point pushbutton — FXPT ID.
3. Fix mode selector knob—VISUAL AUTO.
4. ODS mode selector—CMD.
5. Aiming reticle cage lever—Uncaged.
6. EVF pushbutton — Depress at time of reticle/target coincidence.
7. Fix mode selector knob—OFF.
8. Fixpoint identification selected sequence number—Recorded.

ALTITUDE CALIBRATE.

(Low Altitude)

Note

Do not attempt low altitude calibration when above 4800 feet above terrain.

1. Radar altimeter—On.
2. Altitude calibration pushbutton—Depressed.
   The READY light will come on.
3. Address select number 1—ELEV.
4. Data switch—ENTRY.
5. Data entry pushbuttons—Enter terrain elevation to nearest foot.
6. Altitude calibration pushbutton — Depressed when over selected point.

ALTITUDE CALIBRATE.

(High Altitude)

Note

Do not attempt high altitude calibration if radar altimeter is locked on.

1. Attack radar mode selector knob—GND VEL.
2. Beta switch—NORM.
3. Range selector knob—15/5.
4. Altitude calibration pushbutton—Depressed.
   The ready lamp will light.
5. Address select number 1—ELEV.
6. Data switch—ENTRY.
7. Data entry pushbuttons—Enter terrain elevation of desired calibration point to nearest foot.
8. Tracking handle enable switch—Depress.
   Place the range cursor on the first return when over the selected point.
9. Altitude calibrate pushbutton—Depressed.

WIND VECTOR.

1. Nav mode select pushbuttons—Select TAS only.
2. Altitude calibrate—Completed.
3. Present position—Updated.
4. Fix mode selector knob—WIND VECT.
5. Tracking handle enable switch—Depressed.
   Position the cursors on any radar return and release the enable switch. After allowing cursors to drift off the return, depress enable switch, replace cursors on the radar return and then release the enable switch.
6. Fix mode selector knob—OFF.

Note

Repeat steps 4 thru 6 if another wind vector is required.

MANUAL SEQUENCING PROCEDURES.

1. Manual sequence and display pushbutton—Depressed.
   In the manual mode the button will be lighted and steering signals will continue to be provided to the current steer point.
2. Arrival at current steer point:
   a. Selected sequence point pushbutton—Depressed.
      Select destination/target as desired.
   b. Sequence number set wheels—Set.
      Set to the sequence number of the desired destination/target.
   c. Sequence number select pushbutton—Depressed.

Note

- Repeat the above procedure upon arrival at each current steer point. When automatic sequencing is desired again, depress MAN SEQ and DISP button.

- After overflying the current destination, right hand race track orbit steering is provided until a new destination/target is selected. If the current steering point is a target, constant ground track steering is provided in the bomb nav mode after release until a new destination/target is selected.

MANUAL NAVIGATION.

1. Function select knob—MANUAL.
   NDU selected sequence point displays will blank and constant ground track steering signals will be provided to the pilot's instruments and the autopilot.
2. Selected sequence point pushbutton—Depress.
3. Coordinates—Entered.
   a. Data switch—ENTRY.
   b. Address select number 1 knob—DATA NO.
   c. Clear pushbutton—Depressed.
   d. Address select number 1 knob—LAT, LONG, and ELEV.
      With the data entry pushbuttons, enter the coordinates and elevation of the desired point. When coordinates are entered and accepted by the computer the selected sequence point displays will unblank and appropriate steering commands/cursor positioning is provided.

Note

If it is desired to change any part of the entered coordinate data, a complete set of data (LAT, LONG, ELEV) should be entered.

MISSION DATA DESTRUCT PROCEDURE.

1. DCC and AGM-69A system (CAE) power (as applicable)—On.
2. Address selector knobs—No. 1 to arrow, No. 2 to DESTRUCT.
3. Destruct data—Entered.
   Enter a series of nines until the data storage display is filled with nines. Upon entry, the data storage display will blank and then redisplay within 15 seconds.
4. Sequence interrupt to destination 01.
5. Data destruct—Verified.
   Use the "Sequence Number Verification" checklist to verify that the mission data displays all zeros for destinations, targets, offsets, and fixpoints in the GNC (WDC off), then in the WDC (GNC off). For SRAM, also verify mission data memory is destroyed by performing the "Target Data Verification" procedure. Zero values will be displayed for all parameters except class values which will be down.

GUIDANCE TRANSFER ALIGNMENT (TAL) PROCEDURE.

Note

The TAL procedure must be performed a maximum of 15 minutes prior to each missile launch to complete missile guidance azimuth alignment. A TAL performed later than 2 minutes prior to launch may not be accepted.

1. Select and monitor knob—ALL.

P 2. TAL procedure—Accomplished.
   Perform one of the following maneuvers as appropriate depending on flight conditions and mission profile:
   a. Perform a transfer alignment coordinated turn in accordance with T.O. 1F-111(B)A-30-1.
   b. Increase or decrease ground speed by 119 knots or more within 31 seconds or less.

Note

It may require up to one minute for the MSL NO GO lamp to go out following the TAL procedure. If lamp does not go out and conditions permit, accomplish a second TAL. Once out the lamp should remain out for a minimum of 15 minutes.

3. MSL NO GO lamp—Out. (Within 1 minute)
   Check that the MSL NO GO lamp goes out and MSL GO lamp remains lighted, indicating the missile azimuth alignment error test has been passed.

Note

If, following successful accomplishment of the TAL procedure, any individual MSL NO GO lamp remains lighted, in conjunction with the MSL GO lamp lighted, it is an indication of missile position error test failure, launch of a missile with this type of failure will result in degraded performance.

4. MSL NO GO lamp (all powered missile positions)—Out.
   Position the select and monitor knob to each powered missile position. Check MSL GO lamp lighted and MSL NO GO lamp out in each position.
5. Select and monitor knob—ALL.

TARGET DATA CHANGE.

Note

Target data numbers 301 through 312 (targets 1 through 12) are used for preprogrammed targets; 1 through 6 are primary and 7 through 12 are alternate. Target data number 313 is used for the last fixpoint identification transferred to the target tables.

1. Target data number (301 to 313)—Entered.
2. Target latitude and longitude change (if required)—Entered.

Note

- If Class I change is made, an appropriate target elevation change must be made. The following criteria apply:
    a. For Class I-UP, enter target elevation above sea level; values accepted range from 0 to +30,000 feet.
    b. For Class I-DN, radar altimeter flight, enter command elevation between the minimum altitude and 2000 feet.
    c. For Class I-DN inertial flight, enter an altitude greater than 2000 feet.
- Class I, II and III data may be changed with ADDR SEL NO. 1 in LAT, LONG, or ELEV.

3. Elevation change (if required)—Entered.
4. Data switch—DISP.
5. Target latitude, longitude and elevation—Verified.
6. Class I, II and III—Changed. (As required)
   Position the AGM-69A select and monitor knob to the desired class, and momentarily position the CLASS switch to UP or DN. Monitor the CLASS UP or CLASS DN lamps for the corresponding response. Repeat for all class changes required. Return the AGM-69A SEL & MON knob to ALL.
7. Data number—Cleared.
8. Missiles/Target change—Accomplished. (As required)

MISSILES PER TARGET CHANGE.

Note

If a target is to be removed as an active target for ranging, without losing target data, insert "0" for missiles per target. If a target is to be reinstated as an active target for ranging, insert a value other than "0" for missiles per target.

1. Data number 319—Entered.
2. Address selector knob No. 1—ELEV.
3. Clear pushbutton—Depressed. (Momentarily)
4. Missiles per target data—Entered. (+3XXN4)
   Enter the following data: plus (+), target data number (301-313), missiles per target (N=1-6), and SIC number (4). Depress ENT pushbutton momentarily. The data storage display will blank and then redisplay (+3XXN4) within 15 seconds along with data number 319.
5. Missiles per target—Verified. (If required)
   If missiles per target verification is required, accomplish "Missiles Per Target Verification" procedures.

RANGING PRIORITY CHANGE.

Note

A target table of primary targets is stored in the missile prelaunch data computer under target data numbers 301 through 306. An additional block of target data numbers, 307 through 312 constitute alternate targets. To switch computer target ranging to the alternates, data number 319 and SIC number 2 must be entered into the computer. To revert to ranging on the primary targets SIC number 3 must be entered.

1. Data number 319—Entered.
2. Address selector knob No. 1—ELEV.
3. Clear pushbutton—Depressed. (Momentarily)
4. SIC number—Entered. (+2 or +3)
   Enter a (+) and then either SIC number (2) or (3). Number 2 changes ranging priority to alternate targets (307 through 312), and number 3 reverts the ranging priority to primary targets (301 through 306). Depress ENT pushbutton momentarily.

TARGET FIXPOINT IDENTIFICATION (313).

Note

For maximum system accuracy a fixpoint identification should be accomplished following a present position update.

1. Fixpoint identification—Accomplished.
   Accomplish the appropriate radar, RHAWS or visual fixpoint identification.

WARNING

The missile system can receive fixpoint identification data from the DCC. The latitude and longitude available from the DCC are those of the last fixpoint identification accomplished. When entered into the AGM-69A target table these coordinates become available for active ranging and launch. The RHAW/RDR mode switch must not be actuated unless active ranging is desired on the last fixpoint identification stored.

2. RHAW/RDR mode switch—RDR or RHAW. (Momentarily)
   Momentarily positioning the RHAW/RDR mode switch on the AGM-69A control and display panel to RDR or RHAW transfers fixpoint identification information from the DCC to the missile prelaunch data computer target table for target data number 313.
3. Target data number 313 elevation—Entered.
   a. *For a Class I-UP missile flight enter target* elevation.
   b. For a Class I-DN missile flight enter an elevation corresponding to the maximum terrain deviation along the expected missile flight path.
4. Missile per target and class parameters—Modified. (If required)
   The computer program assumes the number of missiles assigned for target data number 313 is one and all class parameters are down unless preplanned class values were inserted or modified by "Missiles Per Target Change" or "Target Data Change" procedures.

TARGET TABLE RESET PROCEDURES.

1. DCC and AGM-69A system (CAE) power—On.
2. Data number 319—Entered.
3. Address selector knob No. 1—ELEV.
4. SIC number (+14)—Entered.
   Enter a (+) and then SIC number 14. Depress ENT pushbutton momentarily. The data storage display will blank and then redisplay SIC +14 within 15 seconds along with data number 319.
5. Target data reset—Verified. (If required)
   Verify target data reset by performing the target data verification procedure. Zero values will display for all parameters except class values which will all be down.

Note

If target data cannot be reset by use of SIC +14, accomplish "Mission Data Destruct Procedure" or request that AMS personnel reload the operational program tape.

HIGH ALTITUDE LAUNCH MACH NUMBER ENTRY.

1. Data number 319—Entered.
2. Address selector knob No. 1—ELEV.
3. Clear pushbutton—Depressed. (Momentarily)
4. Mach number—Entered. (+XXX13)
   Enter in the following data: Plus (+), launch mach number (between 0.35 and 1.70), and SIC 13. Depress ENT pushbutton momentarily.

OTL CARRIER POWER APPLICATION.

P 1. Communications with range—Established.
   Establish communications with range control and determine when to apply power to missile NTIK.

Note

The missile system provides the capability to automatically launch under computer control a maximum of two NTIK equipped missiles from any two of the six missile stations.

2. AGM-69A control and display OTL panel:
   a. Select and monitor knob—Selected MSL POS.
   b. OTL switch—CARR.
   c. Power switch—ON. (Momentarily)
   d. OTL CARR POWER lamp—Lighted.
   e. Additional NTIK missile—OTL carrier power applied. (If required)
      If required accomplish substeps a through d for second NTIK missile.
   f. OTL switch—N.
3. Test range verification of NTIK on carrier power:
   a. Select and monitor knob—Selected MSL POS.
   P b. Range—Contacted.
      Contact range officer and give notification to proceed with test and monitor of NTIK functions via telemetry.
   c. C/D RCVR READY lamp—Lighted.
   d. Additional NTIK missile—Checked. (If required)
      If required accomplish substeps a through c for second NTIK missile.

P e. Telemetry and radar acquisition—Verified.
Through ground communication, receive verification of telemetry and radar acquisition.

P f. Range clearance—Received.
Obtain range permission to fly test launch.

OTL BATTERY POWER APPLICATION.

Note

Accomplish the following steps during the "Pre Bomb/Pre Launch — Strike/OTL" and approximately four minutes prior to launch.

1. AGM-69A control and display OTL panel:
   a. Select and monitor knob—Selected MSL POS.
   b. OTL switch—BAT.

Note

Upon application of battery power, a seven minute elapse timer within the missile prelaunch data computer is initiated for the selected missile. Missile launch must be accomplished within cumulative seven minute battery time period or the missile will be declared no-go.

   c. Power switch—ON. (Momentarily)
   d. OTL BAT PWR lamp—Lighted.
   e. OTL CARR PWR lamp—Out.
   Carrier power is automatically turned off to the selected missile following application of battery power.
   f. Additional NTIK missile—OTL battery power applied. (If required)
   Repeat substeps a through e for a multiple NTIK missile launch.
   g. OTL switch—N.
2. Test range verification of NTIK on battery power:
   P a. Range—Contacted.
   Contact range officer and give notification to proceed with test and monitor of NTIK functions via telemetry.
   b. C/D RCVR READY lamp—Lighted.
   P c. Telemetry and radar acquisition—Verified.
   Through ground communications, receive verification of telemetry and radar acquisition.
   P d. Range Clearance—Received.
   Receive range permission to launch.

AVIONICS SYSTEMS LAMP ANALYSIS.

Note

- If the INS is recycled with missiles powered-up, missile electronic power must be reapplied as all missiles are powered-down.
- When any avionics caution lamp lights, attempt to reset. If reset is unsuccessful accomplish a recycle if necessary. If the lamp lights again, refer to the "Avionics Systems Analysis," figure 4-1.

A reset is defined as depressing the avionics caution lamp twice for a single reported malfunction, or three times for two reported malfunctions, etc., and the caution lamp remaining out. A recycle is defined as removing power from the applicable system, i.e., GNC/WDC off then GNC, WDC simultaneously, ground align knob off then on, astro deselected then selected, or doppler deselected then selected as applicable.

Note

- Sound judgment should be exercised and all available indications checked before recycling a system for a reported malfunction. Indiscriminately recycling a system for a reported malfunction may not always be the best corrective action.
- INS power must be cycled in order to perform an in-flight alignment, refer to "DCC Recovery and INS Inflight Alignment."

SRAM SYSTEM MALFUNCTION ANALYSIS.

CAUTION

Do not depress the malfunction and indicator lamp test button while a target is displayed on the computer control unit. To do so may change class parameters of targets stored in the target table in the missile prelaunch data computer.

Fault analysis procedures that have an indicator associated with the fault should begin with a lamp test. During a lamp test, all panel indicator lamps are cycled one second lighted and one second out. Indicators that normally blink to reflect status, SRAM PWR, SRAM indicator on BNDT, and SAFE IN RANGE, flash at the rate of 3 to 5 cycles per second. If the fault indication is determined to be valid, isolate malfunction by rotating the select and monitor knob through associ-

Avionics Systems Analysis

Date: 19 May 1972

FAULT MESSAGE	PROBABLE CAUSE	EFFECT	OPERATOR ACTION
COMP 1	GNC fault	Loss of GNC; astro, wind vector fix, two-axis trim, and CRS LINE and MAN CRS steering	Recycle or turn GNC off
COMP 2	WDC fault	Loss of WDC; Homer Set/Track fix modes, built-in test, self-test, HSD	Recycle or turn WDC off
COMP CHAN 1	Area 1 of converter set	Loss of GNC; astro, wind vector fix, two-axis trim	Recycle or turn GNC off
COMP CHAN 2	Area 3 of converter set	Loss of WDC; Homer Set/Track fix modes, built-in test, self-test, HSD	Recycle or turn WDC off
DISP CHAN 1	Area 1—panels channel fail	Loss of GNC; astro, wind vector fix, two-axis trim	Recycle or turn GNC off
DISP CHAN 2	Area 3—panels channel fail	Loss of WDC; Homer Set/Track fix modes, built-in test, self test, HSD	Recycle or turn WDC off
COMP CHAN	GNC-WDC channel	GNC & WDC in backup mode	Recycle or turn GNC or WDC off
CS 1	Converter set area 1	Loss of GNC; astro, wind vector fix, two-axis trim	Recycle or turn GNC off
CS 3	Converter set area 3	Loss of WDC; Homer Set/Track, built-in test, self-test, HSD	Recycle or turn WDC off
CS 2	Area 2 analog output fail	System/mode degradation dependent on analog signal failure	Operation can be continued but performance may be degraded
CS	Area 1 or 3 analog input fail	System/mode degradation dependent on analog signal failure	Operation can be continued but performance may be degraded
CS MODE 2	Area 2 primary ladder fail	No mode degradation	None
COMP 1 HEAT	GNC overtemperature	Possible GNC failure	Turn GNC off unless use is absolutely necessary
COMP 2 HEAT	WDC overtemperature	Possible WDC failure	Turn WDC off unless use is absolutely necessary
INS 1	IRU NO GO	Loss of INS	In-Flight Align or turn INS off
INS 2	NCU NO GO	Loss of INS	In Flight Align or turn INS off
INS 3	Battery unit NO GO	Loss of INS battery unit	None
INS CHAN 1	NCU CS area 1 channel fail	Loss of I nav mode	1 only, turn GNC off 1 & 3—no action
INS CHAN 3	NCU-CS area 3 channel fail	Loss of INS backup channel	3 only—no action 1 & 3—no action
INS 1 HEAT	IRU overtemperature	Loss of INS	Turn INS OFF, after cooling period, attempt inflight align
INS 2 HEAT	NCU overtemperature	Loss of INS	Turn INS OFF, after cooling period, attempt inflight align
INS 3 HEAT	BU overtemperature	Loss of INS	Turn INS OFF, after cooling period attempt inflight align
INS MODE	Excessive gyro drift rate	Possible degradation of inertial aided navigation	a. None if navigation is satisfactory b. Select DR Nav or In-Flight Align if navigation is unsatisfactory
INS MODE 1	Mag heading input to INS failed	Possible degraded magnetic heading	Manually update mag var as required
INS MODE 2	NCU acft converter failure	Loss of primary heading to flight instruments, auto tilt to ARS, D & A aided nav modes	None
INS MODE 3	IRU synchro output fail	Loss of primary attitude and heading	None
AC/DP RADAR CHAN	DRS-CS channel fail	Loss of communication from doppler	Turn DRS OFF
AC/DP RADAR	DRS BIT	N/A	N/A
AC/DP RADAR MODE	DRS-CS channel fail during BIT	Loss of communication to/from doppler	Deselect DRS BIT; turn DRS OFF
AC/DP RADAR 1	DRS antenna fail	Loss of doppler	Turn DRS OFF
AC/DP RADAR 2	DRS electronics unit fail	Loss of doppler	Turn DRS OFF
AC/DP RADAR 1 & 2	DRS antenna and electronics unit fail	Loss of doppler	Turn DRS OFF
AC/DP RADAR 3	DRS BIT accuracy test fail	Possible degradation of doppler aided navigation	Deselect D mode
AC/DP CHAN	ACS-CS area 1 channel fail	Loss of communication to/from astrocompass	★Depress star advance. Recycle ACS power switch or turn ACS OFF
AC/DP	Astro BIT	N/A	N/A
AC/DP MODE	Astro-CS channel fail during BIT	Loss of communication to/from astrocompass	Deselect astro BIT; turn ACS OFF
AC/DP 1	ATU fail	Loss of astrocompass	Turn astro OFF
AC/DP 2	AEU fail	Loss of astrocompass	Turn astro OFF
AC/DP 1 & 2	ATU/AEU fail	Loss of astrocompass	Turn astro OFF
RADAR CHAN 1	ARS-CS area 1 channel fail	Loss of communication from ARS	1 only—turn GNC OFF
DISP 3	HSD symbology unit	Loss or degraded operation of HSD	HSD operation can be continued but performance will be degraded
DISP MODE	HSD channel fail during BIT	Loss of communication to/from HSD	Use manual chart positioning and data frame capability
MODE	Function switch in RADAR BOMB and stores station not selected	System not in bomb mode	As required
	In the bomb mode and ISC in any position but BOMB/NAV	HSI steering display in error	As required
	Function switch in RADAR BOMB and current route point is a destination	System not in bomb mode	As required
RADAR CHAN 3	ARS-CS area 3 channel fail	No mode degradation	3 only—No action 1 & 3—Operate attack radar in ground manual or air modes
RADAR CHAN 2	CS-ARS channel fail	Loss of ARS in GRD VEL/AUTO	Operate attack radar in ground manual or air modes
CHAN 1 & 2	SRAM-CS area 1 channel fail	No mode degradation if SRAM is good	None
CHAN 2 & 3	SRAM-CS area 3 channel fail	No mode degradation if SRAM is good	None
CHAN 1 & 3	INS SRAM channel fail	Loss of SRAM launch capability	Turn SRAM OFF
DISP CHAN	HSD SU-PU channel fail	Loss of automatic HSD chart operation	Use manual chart positioning and data frame capability
DISP CHAN 3	HSD-CS area 3 channel fail	Loss of automatic HSD chart operation	Use manual chart positioning and data frame capability
DISP	HSD BIT	N/A	N/A
DISP 1	HSD indicator unit fail	Loss or degraded operation of HSD	HSD operation can be continued but performance will be degraded
DISP 2	HSD processor unit	Loss or degraded operation of HSD	HSD operation can be continued but performance will be degraded

Figure 4-1.

Missile Battery Warmup Time

OUTSIDE AIR TEMPERATURE °F	TIME SINCE SYSTEM (CAE) POWER APPLICATION MINUTES
+5 AND ABOVE	40
0	42
−5	45
−10	48
−15	50
−20	54
−25	56
−30	58
−35	62
−40	65
−45	67
−50	70
−55	74
−60	77
−65	80

NOTES:

(1) MISSILE ELECTRONIC POWER APPLICATION INHIBITED BY MISSILE PRELAUNCH DATA COMPUTER FOR 40 MINUTES.

(2) THE OUTSIDE AIR TEMPERATURE USED SHOULD BE THE AVERAGE GROUND TEMPERATURE FOR THE 24 HOUR PERIOD PRIOR TO TAKEOFF.

(3) THE TIME SINCE SYSTEM POWER APPLICATION REPRESENTS REQUIRED MISSILE BATTERY HEATER-ON TIME PRIOR TO MISSILE LAUNCH.

Figure 4-2.

ated positions, note indications, reset MASTER MAL and MASTER CAUTION displays as applicable and proceed with malfunction analysis. Refer to figure 4-3.

SIC DATA TABLE.

Data may be manually loaded into the missile computer during flight by entering the SIC's into the CCU. SIC's can also be used to request the display of stored data which may be needed on a non-routine basis and for certain tests. Refer to figure 4-4.

TF FLY UP CAUSES.

The TF fail fly up is caused by one of several conditions. These conditions are: (1) the TFR system detects an internal malfunction, (2) the TFR system detects an excessive error in comparison of certain inputs to the TFR, (3) the TFR system detects a loss of one or more input data good signals from other systems, and (4) altitude (AGL) is less than 83% of selected set clearance. Refer to figure 4-5 to determine TFR system indications of loss of good data signals.

OPERATING PROCEDURES. (NON-NUCLEAR)

BOMBING EQUIPMENT CHECK.

1. Safety check:
   a. Delivery mode knob—OFF.
   b. Selector mode knob—OFF.
   c. Bay door control switch—CLOSE.
2. Selected sequence point pushbutton—TARGET depressed.
   Verify that current steer point is a target.
P 3. Instrument systems coupler—BOMB/NAV.
P 4. Optical display system mode knob—CMD.
5. Stores control panel:
   a. Release enable switch—INHIBIT.
   b. Master switch—ON.
   c. Delivery mode knob—BOMB. (RBS only)
   d. Station select switch—Station selected.

WARNING

To prevent an inadvertent release, do not select a station with a bomb loaded. (On a normal training mission do not select any store loaded station).

6. Function select knob—RADAR BOMB/MANUAL.
7. UHF # 1—Unused channel. (RBS only)
8. Attack steering—Checked.
   Using tracking handle check for aircraft responses to left and right turns and that the aircraft returns to straight and level flight.

SRAM System Malfunction Analysis

FAULT MESSAGE	PROBABLE CAUSE	EFFECT	OPERATOR ACTION
1. CARRIER AIRCRAFT EQUIPMENT FAULTS			
COMP lamp on. Select and monitor knob: Any position.	Missile prelaunch data computer has failed self-test.	All computer functions are lost.	If fault occurs early in mission and time permits, recycle system (CAE) power.
Isolation: All other indications except SYS GO remain as they were when COMP caution lamp comes on.			If missile power was on prior to fault and off less than 5 minutes, use SIC 319 +21 to bypass 40 minute warmup timer on restart.
PDU lamp on. SRAM PWR lamp on. Select and monitor knob: CAE, OFF.	Signal data distributor-processor has failed self-test.	All communication functions with DCC, missile, and missile prelaunch data computer are lost.	If fault occurs early in mission and time permits, recycle system (CAE) power.
Isolation: Select and monitor knob: All other positions—SRAM PWR lamp off.			If missile power was on prior to fault and off less than 5 minutes, use SIC 319 +21 to bypass 40 minute warmup timer on restart.
REL CMD lamp on and neither weapon release switch was depressed. Select and monitor knob: Any position.	Manual release command issued by CPU.	Possibility of unplanned launch. System will react as if in automatic launch mode.	Reset release command from CPU by positioning delivery mode knob to OFF, check REL CMD lamp off. Position delivery mode knob to SRAM MAN, monitor REL CMD lamp. If REL CMD lamp will not go out positive launch control may be maintained through nuclear consent switch, stores station select switches, or delivery mode knob.
MAST MAL lamp on. All other indications are normal. Select and monitor knob: Any position except CAE.	1. Unsatisfactory CPDU initialization results.	Possible launch inhibit.	If CHAN 1 & 2 faults are indicated, turn off SRAM system, refer to Abort Procedure. Continue with mission in accordance with command guidance.
Isolation: Select and monitor knob: CAE—MAST MAL caution lamp off.	2. Lamp test failure.	Loss of reliable monitoring capability.	Proceed in accordance with command guidance.
	3. Improper output from select and monitor knob—associated with changing switch positions.	Computer assumes ALL position. Reduced control capability.	Strike or simulated launch mission—continue with no individual missile select and monitor capability. If practical, recycle knob. OTL mission—proceed in accordance with command guidance.
	4. Automatic and manual launch mode signals both being received by computer—associated with changing delivery modes.	Only manual launch is possible.	Strike mission—continue using manual launch procedures. Simulated or OTL mission—proceed in accordance with command guidance.
	5. Test and clear malfunction commands both being received by computer associated with activation of MSL switch.	Missile test and clear cannot be commanded from panel.	None required—continue with mission.
	6. Class parameters up and down both being sensed by computer—associated with class change.	Class parameters will be as set in target table.	Proceed in accordance with command guidance.
	7. Class III override commands up and down both being received by computer.	Target table values will be used.	None required, launch will employ class III value from target table.
	8. Power on and off commands both being received by computer—associated with an attempt to remove missile power.	Power cannot be removed by panel originated command.	Missile electronic power may be removed by accomplishing or continuing with abort procedure. Refer to command guidance
	9. OTL carrier and battery power commands both being received by computer—associated with actuation of OTL switch.	OTL battery power cannot be applied or maintained.	Abort OTL mission—launch will be inhibited.
	10. Cannot be accurately determined by aircrew.	Indeterminate.	Clear MAST MAL and proceed in accordance with command guidance.
Sudden, complete, and uncommanded system power off. Select and monitor knob: Any position.	CPDU and/or computer overheat condition.	All launch functions are lost.	Check FWD EQUIP HOT caution lamp and operation of air conditioning system. If normal, attempt restart.
2. MISSILE AND POWER FAULTS			
ALT and MAST MAL lamps on. Select and monitor knob: ALL, CLASS, OFF, CAE—SRAM PWR on. Isolation: Select and Monitor knob: Failed MSL POS—MAST MAL off. Other power MSL POS—ALT off.	Malfunction of missile radar altimeter.	1. Launch is possible only in manual mode. 2. Missile low level terrain following flight is not possible.	Proceed with manual launch using semi-ballistic or low level inertial flight mode. Refer to command guidance.

Figure 4-3. (Sheet 1)

SRAM System Malfunction Analysis (Cont'd)

FAULT MESSAGE	PROBABLE CAUSE	EFFECT	OPERATOR ACTION
2. MISSILE AND POWER FAULTS (Cont'd)			
SAF NO GO and MAST MAL lamps on. MASTER CAUTION and SRAM caution lamps also on. Select and monitor knob: ALL, CLASS, OFF, CAE — SRAM PWR on. **Isolation:** Select and monitor knob: Failed missile position — MAST MAL lamp off. Other powered MSL POS — SAF NO GO off.	SAF monitor circuit open.	1. Launch is possible only in manual mode. 2. Warhead fuzing may not occur.	Proceed with manual launch in accordance with command guidance.
ORD ALM and MAST MAL lamps on. SRAM PWR on. MASTER CAUTION and SRAM caution lamps on. Select and monitor knob: ALL, CLASS, OFF, CAE. Isolation: Select and monitor knob: Failed MSL POS — MAST MAL and SRAM PWR off. Select and monitor knob: Other MSL POS—ORD ALM off.	1. Propulsion system armed. 2. OTL C/D device armed.	Affected missile cannot be launched. No-go is not overrideable.	Position option select switch on DCU-137/A to SAFE. Motor arm command is applied simultaneously to all missile motor arm/disarm switches. Check ORD ALM lamp out. Proceed in accordance with applicable safety regulations and command guidance. If applicable, deselect faulted missile and prearm "go" missiles. **Note** An armed OTL C/D device cannot be safed inflight.
MSL NO GO and MAST MAL lamps on. MSL GO and SRAM PWR lamps on. (True missile no-go) Select and monitor knob: ALL, CLASS, OFF, CAF. Isolation: Select and monitor knob: Failed MSL POS—MAST MAL, MSL GO, and SRAM PWR lamps off. Select and monitor knob: All other MSL POS—MSL, NO GO lamps off.	Failure of missile to pass computer initiated tests.	Missile is declared no-go by prelaunch data computer, power cannot be applied or is removed, and missile is not available for launch.	Strike mission—attempt to restart with the following rules in mind: a. Insert SIC 319 (+7) to reset current FIRT. This enables restart of faulted missile(s). b. If no-go occurs as a result of missile electronic power application, one restart attempt should be made since little missile alignment time will be lost by shutdown of other missiles. c. If a no-go occurs after missile alignment is well developed and prior to countdown entry, consideration must be given to time lost (9 to 10 minutes minimum) by shutdown and realignment of missile. d. If condition of missile is questionable, hold restart attempt until after all other missiles have been launched. Simulated launch or OTL mission—attempt restart or accomplish abort procedures in accordance with command guidance.
TEMP lamp blinks on attempted missile electronic power application. Select and monitor knob: Any unpowered MSL POS.	SRAM cooling switch not in SRAM COOLING position or missile air conditioning system malfunction.	Missile electronic power cannot be applied.	Position SRAM cooling switch to SRAM COOLING.

Figure 4-3. (Sheet 2)

SRAM System Malfunction Analysis (Cont'd)

FAULT MESSAGE	PROBABLE CAUSE	EFFECT	OPERATOR ACTION
2. MISSILE AND POWER FAULTS (Cont'd)			
TEMP and MAST MAL lamps are on. Select and monitor knob: ALL, CLASS, OFF, CAE. Isolation: Select and monitor knob: Failed MSL POS—MAST MAL off. Select and monitor knob: Other MSL POS—TEMP off.	Missile cold-plate temperature out of acceptable range. (Below 32°F or above 150°F).	1. Degraded alignment accuracy if temperature is low. 2. High temperature will inhibit application of missile electronic power. 3. TEMP fault after missile power application inhibits automatic launch.	1. Strike Mission—proceed with manual launch. Refer to command guidance. 2. Simulated launch or OTL mission a. If the lamp comes on for an individual missile shortly after missile power application (insufficient warmup prior to power application) reserve missile for later launch in event missile coldplate temperature goes to acceptable range. b. If the lamp comes on for an individual missile after missile electronic power has been on for some time (coldplate temperature is increasing with time). Use missile for next launch (in manual mode) or consider shutdown. Refer to command guidance. c. If lamp comes on for all missiles after missile electronic power has been on for some time check SRAM cooling switch in SRAM COOLING position. If condition does not clear in a short time shut off missile and system power.
Missile power fails to turn off when commanded. MSL NO GO and MAST MAL lamps on.	Two or more missiles with this fault indicates W/B TR unit failure.	Loss of all missile electronic power.	Check individual missile positions. If more than one missile displays malfunction, remove system power and proceed in accordance with command guidance.
MSL GO and SRAM PWR lamps on (latch reset). Select and monitor knob: ALL, CLASS, OFF, CAE. Isolation: Select and monitor knob: Failed MSL POS—MAST MAL and MSL go lamps off. SRAM PWR on. Select and monitor knob: All other powered MSL POS—MAST MAL, MSL GO, and SRAM PWR on.	One missile with this fault indicates CPU malfunction or relay failure in associated SPU.	Missile electronic power cannot be removed, however, missile is not available for launch.	Do not remove SRAM cooling. Removing SRAM cooling with missile electronic power applied can result in missile overheat damage.
SRAM PWR lamp on along with MAST MAL lamp. Select and monitor knob: ALL, CLASS, OFF, CAE. Isolation: Select and monitor knob: Failed MSL POS—no display.	Uncommanded missile electronic power off.	Affected missile is not available for launch.	If mission time permits: 1. Remove electronic power from all missiles. 2. Reset current FIRT by inserting S/C 319 (+7). 3. Reapply electronic power to missiles.
3. ALIGNMENT FAULTS			
MSL NO GO lamp is on along with MSL GO and SRAM PWR lamps. Select and monitor knob: ALL, CLASS, OFF, CAE, and all powered MSL POS.	Azimuth alignment error.	Degraded CEP.	Accomplish transfer alignment procedure.
MSL NO GO lamp is on along with MSL GO and SRAM PWR lamps. Select and monitor knob: Failed MSL POS only.	Position error test failure (estimated).	Degraded CEP. A true missile no-go may develop.	Continue mission until alignment is refined or missile becomes no-go.

Figure 4-3. (Sheet 3)

SRAM System Malfunction Analysis (Cont'd)

FAULT MESSAGE	PROBABLE CAUSE	EFFECT	OPERATOR ACTION
4. LAUNCH COUNTDOWN FAULTS			
SRAM PWR lamp blinks longer than the 5 seconds normally required for a launch countdown. (Launch hold condition). Weapon present and station select lamps for missile that was to have been launched remain lighted. Select and monitor knob: Any position other than CAE or OFF.	1. Failure to pass safe launch test (SAFE IN RANGE lamp blinking)—carrier level flight and altitude parameters not within safe launch. 2. Missile or carrier condition preventing launch of "go" missile.	Countdown has entered a hold period. Missile will become no-go if countdown is not resumed prior to expiration of 15 minute or 45 second hold timer.	1. Maintain aircraft altitude/attitude/acceleration within limits for launch. 2. If weapons bay missile, check weapons bay door position indicator. If indicator does not read OPEN, position weapons bay door control switch to OPEN. Then, if doors still do not open, position weapons bay door auxiliary switch to AUX. **Note** The above faults must be corrected within 45 seconds. 3. Check if any of the following may have occurred after entering the launch countdown. a. Removal of nuclear consent (prearm and unlock). b. Change of launch mode. c. OTL Removal of OTL battery power. d. OTL Application of NTIK carrier power.
			If any of these situations exists, correct as soon as possible. Once a missile has entered a launch countdown, no other missile can be selected for launch until the missile in countdown is either launched or declared no-go or jettisoned. Launch modes on a missile in a 45 second hold cannot be changed. If the missile is not launched prior to expiration of the launch hold timer, it will be declared no-go and will be shut down. If, for any reason, it is desired to select another missile for launch during one of these holds, it will be necessary to remove electronic power from the missile in hold status prior to selecting the new missile.

FAULT MESSAGE	PROBABLE CAUSE	EFFECT	OPERATOR ACTION
At countdown entry: all displays are normal for launch (SAFE IN RANGE on steady) but missile will not enter launch countdown (SRAM PWR lamp does not blink). Select and monitor knob: Any position.	Alignment 2.5° tilt error.	Missile prelaunch data computer will inhibit launch of affected missile until condition corrects or missile becomes no-go.	Strike and simulated launch mission—select a different missile for in-range target. OTL mission—accomplish abort procedures if range time cannot be extended for possible alignment correction.
MAST MAL and MSL NO GO lamps on. MSL GO and SRAM PWR lamps on. (Launch no-go) Select and monitor knob: ALL, CLASS, OFF, CAE. Isolation: Select and monitor knob: Failed MSL POS—MAST MAL, MSL GO, and SRAM PWR lamps off.	1. Power manually removed after battery activation. 2. Removal of launch consent after last data transmission. 3. Expiration of launch hold timer. 4. Missile fails to eject. 5. OTL expiration of NTIK battery 7 minute timer.	Missile is not available for launch.	Proceed in accordance with command guidance.
SAFE IN RANGE lamp blinks prior to start of countdown. (Target in range but safe launch conditions not satisfied) Select and monitor knob: Any position.	1. Carrier attitude not safe limits for launch. 2. Carrier below minimum launch altitude. 3. Class I Down selected and carrier radar altimeter signal not being received by missile prelaunch data computer.	Countdown will not be entered or continued and target may go out of range or 45 sec timer may expire.	1. Correct carrier attitude. 2. Return carrier to altitude above minimum. 3. Class I down is prohibited. Proceed in accordance with command guidance.

Figure 4-3. (Sheet 4)

SIC Data Table

DATA NO.	SIC NO.	FUNCTION
318	± XXXXX	Display memory (XXXXX specifies memory location to be displayed).
319	+ 0*	Enable ground simulated launch.
319	+ 1	Reset fault record and launch scoring data.
319	+ 2	Range on alternate targets (307-312).
319	+ 3	Range on primary targets (301-306) (used only if SIC +2 was in effect).
319	+ 3XXN4	Enter missiles per target in target table (XX is target numbers 01 thru 13; N is number of missiles per target).
319	+ 3XX05	Display number of missiles per target from target table (XX is target numbers 01 thru 13).
319	+ 6	Record aircraft present position (latitude and longitude).
319	+ 7	Reset current fault isolation record table.
319	+ 8*	Enable arm and release circuits test.
319	+ 9*	Enable missile simulator test.
319	+ 10*	Pseudofault channel V.
319	+ 11*	Pseudofault channel 0_{15}.
319	+ 12	Pseudofault channel 0_{35}.
319	+ XXX13	Input planned launch mach number for launches above 30,000 feet (XXX is mach number between 0.35 and 1.70).
319	+ 14	Target table reset.
319	+ X19	SRAM stores select (X = SRAM store location).
319	+ 20*	Weapon bay door open.
319	+ 21	Bypass missile electronic warmup 40-minute timer (only for use in an in-flight emergency situation requiring recycling of system power).

* SIC used for maintenance purposes only.

Figure 4-4.

9. ATF and trail—Checked.
   Check manual or automatic ballistics.

P 10. Pilot calls TG:
   a. Driving.
   b. 60 seconds.
   c. 30 seconds.
   d. 10 seconds, RBS Tone—ZONE 1. (If applicable)

B 11. Release indications—TG ZERO.
   Release lamps light and tone breaks. (If applicable)

Note

The RBS tone may cut and release be indicated with as much as two seconds time to go.

12. Stores control panel:
   - Station select switch—Deselect.
   - Station selected lamp—Out.
   - Master switch—OFF.
   - Delivery mode knob—OFF.
13. Function select knob—As desired.

TFR Warning & Caution Lamp Indications

DATA SIGNALS				
ROLL	LARA	CADC	INERTIAL	LAMPS LIGHT
FAIL	GOOD	GOOD	GOOD	L & R FAIL Caution Lamps & TF Warning Lamp
GOOD	FAIL	GOOD	GOOD	L & R FAIL Caution Lamps & TF Warning Lamp
GOOD	GOOD	FAIL	GOOD	FLT VECTOR Caution Lamp
GOOD	GOOD	GOOD	FAIL	FLT VECTOR Caution Lamp
GOOD	GOOD	FAIL	FAIL	L & R FAIL Caution Lamps & TF Warning Lamp

★ *Figure 4-5.*

PENETRATION AIDS SELF TEST PROCEDURES.

Note

- For detailed description of the Penetration Aids System refer to T.O. 1F-111(B)A-1-3.
- Refer to T.O. 1F-111(B)A-1-3 for Scope and Threat Panel Display.
- Penetration Aids Self Test Procedures are required only for alert acceptance, EWO/ Contingency missions and when equipment reliability is in doubt.

1. RHAWS confidence checks:

Note

There are three confidence checks for the RHAWS: the lamp test, the display test, and the system test. The lamp test checks all RHAWS and IRRS lamps. The display test checks only the ability of the RHAW scope to display video. The system test checks all RHAWS components except the antennas.

a. Turn on:
   (1) Power/audio control knob—CW out of detent. (Approximately 2 minutes warm up required).
   (2) Scope filter—As desired.
   (3) Gate selector knob N.
   (4) Brightness knob—Full CW.
   Moving the knob full CCW has the same effect as increasing memory.
   (5) Reticle intensity knob—As required.
   (6) Sensitivity control knob—Full CW.
   (7) Memory control knob—Full CCW.

b. Lamp test: (Check lamps only)
   (1) Test knob—Lamp.
   (2) All indicator lamps—Lighted.
   (a) Check cryo fail lamp.
   P (b) Check pilot's remote threat display.

c. Display test (Checks RHAW scope and TDP).
   (1) Test knob—Display.
   (2) Mode selector knob—IRT.
   Check that target appears in center of scope.
   (3) Mode selector knob—OMO.
   Check that 6 targets appear around the periphery of the scope. Signals will multiplex through the 3 bands.

d. System test:
   (1) Test knob—System.
   (2) Mode selector knob—H1.
   A target should appear on the scope. Center the target on the azimuth cursor and adjust to —3 degree elevation. Monitor the Threat Display Panel (TDP) for the appropriate warning lamps.
   (3) Mode selector knob—H2.
   A target should appear on the scope. Center the target on the azimuth cursor and adjust to —4 degree elevation. Monitor the TDP for the appropriate warning lamps.
   (4) Mode selector knob—H3.
   A target should appear on the scope. Center the target on the azimuth cursor and adjust to —5 degree elevation. Monitor the TDP for the appropriate warning lamps.

(5) Mode selector knob—OMT-F.
Bands 1, 2 and 3 targets with associated threat coding will be displayed at the antenna boresight positions. The threat panel lamps will light in conjunction with the associated targets on the RHAW scope. (See T.O. 1F-111(B)A-1-3 for RHAW scope displays.)

Note

Adjust the memory control knob for desired RHAW scope presentation. Minimum scope persistence settings are recommended.

(5A) ILS communications monitor knob—Fully counterclockwise. (After T.O. 1F-111-1074)

Note

After T.O. 1F-111-1074, the ILS monitor knob on the communications panel can be used to decrease the volume of the TFR aural command thereby insuring the detectability of the RHAWS audio signals and warning tone.

(6) Power/audio control knob—Adjusted.
Insure that RHAWS audio signals and warning tone are detectable. Adjust the level of the warning tones with the RHAW interphone communications monitor knob (controls the level of both the warning tones and radar audio). Then adjust the level of the system tests radar tones with the RHAWS power/audio control knob (controls level of the radar audio only).

(7) Mode selector knob—OMT-A.
Bands 1, 2 and 3 targets will be displayed at the antenna boresight position (0 degrees).

(8) Mode selector knob—OMO.
Bands 1, 2 and 3 targets will be displayed at the designated positions.

(9) Test knob—OFF.

2. CMDS confidence check

WARNING

- Do not place the CMDS arming switch to the ARM position during ground operation. To do so could result in inadvertent dispensing of explosive chaff or flares.
- With expendables loaded, do not perform the CMDS confidence check on the ground unless the CMDS safing plugs are installed, or in-flight until over an authorized dispensing area or during EWO.

a. Arming switch—TEST.
b. TBC mode selector knob—MAN.
c. Aft AI lamp—Depressed.
Disp lamp will blink once.
d. TBC mode selector knob—OFF.
e. MLR mode selector knob—MAN.
f. IR TGT lamp—Depressed.
Disp and AFT AI lamps will blink once.
g. MLR mode selector knob—OFF.
h. SPC mode selector knob—MAN.
i. Aft SAM lamp—Depressed.
Disp lamp will blink once.
j. SPC mode selector knob—OFF.
k. Arming switch—SAFE.

3. ECM confidence check:

WARNING

Prior to turning on equipment, advise all ground crew personnel to move away from the aircraft a minimum distance of 6 feet.

a. ECM control knobs (3)—REC.
(1) RCVR/PA indicator lamps (3) light and remain lighted until system warm-up time expires (approximately 3 minutes).
b. ECM control knobs (3)—ON.

Note

The ALQ-94 ECM system, operating in ON or TEST (prior to initiation of self-test), may create interference with other radars in the local area. This interference will be indicated by lighting of the XMIT threat indicator lamp for the appropriate band. Self-test should be initiated immediately after placing an ECM control knob to the TEST position.

c. ECM warm-up—Completed.
d. ECM low band control knob—TEST.
e. RCVR/PA LOW pushbutton indicator lamp—Depress and hold for 30 seconds, then release.
(1) RCVR/PA indicator lamps will light steady within one minute (blinking light indicates malfunction).
f. To re-initiate the self-test, rotate the ECM control knob to any other position (ON, REC or SPL) then back to TEST. Repeat step e.
g. Repeat steps d thru f for medium and high bands.

Note

In the event of a malfunction indication in REC or ON modes, the system can be reset by placing the control knob to OFF and returning the knob immediately (less than 1/8 second) to REC or ON. This will reset the system without necessitating a warmup delay. If the malfunction has cleared, the system will operate normally. If this procedure does not correct the malfunction, turn the system off for at least 3 minutes, then repeat the turn-on procedure.

4. IRRS confidence checks:

WARNING

With expendables loaded, do not perform the IRRS confidence check on the ground unless the CMDS safing plugs are installed. Do not perform items h through m during flight until over an authorized dispensing area or during EWO.

a. Function selector knob—OPR.
b. CRYO FAIL lamp—Lighted.
c. Function selector knob—STBY.
d. RHAW mode selector knob—IRT.
e. Azimuth blanking control knob—AUTO.
f. Elevation blanking control knob—AUTO.
g. Ready/test indicator lamp—Lighted.
   Ready/test lamp will light within 8 minutes. If the ready/test lamp does not light within 8 minutes, coolant servicing of the cryogenic converter may be marginal.
h. Function selector knob—OPR.
i. Ready/test indicator lamp—Out.
j. Test 1 button—Depress and hold.
   Ready/test lamp should light within 5 seconds. Only the Scan lamp will be on.
k. Test 2 button—Depress and hold.
   Ready/test lamp should light within 5 seconds.
l. CMDS arming switch—TEST.
m. CMDS MLR mode selector knob—NORM.
n. Test 3 button—Depress and hold.
   The IR TGT lamp will light and the target will appear on the right side of the RHAW scope. The IR MLD lamp will light for approximately 5 seconds, the aft AI and IR display lamp will blink within 5 seconds, and the MLD warning tone will activate.
o. RHAW mode selector knob—IRS (IRRS test 3 button depressed).
   Target on right side of RHAW scope should move vertically forming a line; this indicates proper IRRS scanner operation. The length of the line will vary with elevation blanking knob setting and aircraft altitude. (See T.O. 1F-111(B)A-1-3 for proper length.)
p. MLR mode selector knob—OFF.
q. CMDS arming switch—SAFE.
r. Function selector knob—As desired.
s. RHAW mode selector knob—OMO.

PENETRATION AIDS EQUIPMENT PRE-SET.

Note

This procedure will be accomplished prior to any Electronic Warfare activity. If "Penetration Aids Self Test" procedures are performed, "Penetration Aids Equipment Pre-Set" will be accomplished prior to any subsequent electronic warfare activity.

1. RHAWS:
   B a. RHAW communications monitor knob—As desired.
   Controls the warning tones and radar audio levels. Adjust (if not previously accomplished) by setting the desired warning tones level using RHAW lamp test or system test.
   a1. ILS communications monitor knob—Fully counterclockwise. (After T.O. 1F-111-1074)
   b. Power/audio knob—Adjusted.
   Controls only the radar audio. Adjust for the desired level on either actual radar signals or system test radar audio.
   c. Mode selector knob—As desired.
   d. Scan indicator lamp—SCAN.
2. CMDS:
   a. Mode selector knobs (3)—As briefed.
   b. Arming switch—As briefed.

Note

Do not arm CMDS until after chaff/flares clearance has been obtained or the aircraft has entered the designated drop area or has reached a designated vulnerability point.

3. ECM control knobs (3)—As briefed.
4. IRRS:
   a. Function selector knob—As required.
   b. Azimuth blanking control knob—AUTO.
   c. Elevation blanking control knob—AUTO.

FUEL TANK JETTISON PROCEDURES.

Selective jettison of fuel tanks must be accomplished in straight and level flight, with gear and flaps up, at an angle-of-attack less than 8 degrees. Jettison tanks singly, outboard to inboard with no more than one station asymmetry. Tanks must be empty, only residual fuel remaining. Refer to "Stores Limitations", Section V, for tank release limits.

WARNING

To prevent inadvertent jettison of weapons insure that weapon loaded stations are not selected when jettisoning fuel tanks.

1. Stores control panel:
   a. Master switch—ON.
   b. External station selector switches—Deselected.
      All external stations carrying weapons must be deselected, station select lamp out, to prevent jettisoning weapons.
   c. Delivery mode knob—AUX.
   d. Selector mode knob—STA JETT.
   e. Station selector switch (tank to be jettisoned)—Selected.
   f. Station selected lamp—Lighted.
      Station selected lamp for external fuel tank station to be jettisoned should be lighted.
   g. Release enable switch—RELEASE ENABLE.

P 2. Weapon release button—Depressed.

Note

Repeat step 1.e, f and 2 to jettison additional tank(s).

3. Stores control panel:
   a. Release enable—INHIBIT.
   b. Master switch—OFF.
   c. Delivery mode knob—OFF.
   d. Selector mode knob—OFF.

PREDESCENT AND DESCENT (LOW ALTITUDE TACTICAL OPERATION). (PRIOR TO T.O. 1F-111-996)

If TFR is not to be performed, only the ➧ steps must be accomplished. Auto/manual TF letdowns will be made from cruise mach, throttles and airspeed as required. Non-TF descents will be made at cruise mach until intercepting the indicated airspeed that corresponds to the desired low level mach. Adjust to low level mach after level off.

B 1. TFR operational check—Completed.
➧**B** 2. Fuel panel—Checked.
➧**P** 3. Engine inlet anti-icing—Climatic.
➧**B** 4. Altimeters—Reset. (If required)
➧ 5. IFF—Set.
➧**P** 6. AMI and AVVI command airspeed markers and ODS indicated airspeed—Set to desired airspeed and altitude.
➧**P** 7. Radar altimeter—Set as briefed.
8. TFR switches—Set.
   a. Range selector knob—E position.
   b. Ride control knob—As desired.
   c. Volume control knob—As desired.
   d. Terrain clearance knob—1000 feet.

B 8A. ILS communications monitor knob—As desired. (After T.O. 1F-111-1074)
P 9. Radar altimeter bypass switch—BYPASS.
B 10. L and R TFR channel mode selector knobs—TF.
P 11. Reference or ATF not engaged lamp (as applicable)—Lighted.
P 12. Pitch steering mode selector switch—TF.
   a. ADI and ODS pitch steering bars—Indicate dive.
   b. Aural command—Dive.
   c. TF warning and channel fail lamps—Off.
   d. E scope—Checked.
      Check self test pulse and zero command line.

WARNING

If the self-test pulse is absent, do not fly TF under night or IFR conditions.

B 13. Fly-up check—Complete.
   a. Autopilot release lever—Hold depressed. (Prior to T.O. 1F-111(B)A-593)
   b. Autopilot release/PCSS lever—Depress and hold to first detent. (After T.O. 1F-111(B)A-593)
   c. Radar altimeter control knob—Depress and hold.
      (1) Bypass switch—Return to NORMAL.
      (2) Off warning flag—Out of view.
      (3) Indicator pointer—95 (±12) feet.
      (4) TFR failure warning and channel fail caution lamps—Lighted.
      (5) ADI and ODS pitch steering bars—Full fly-up command.

(6) Aural command—Full climb. (If above 5000 feet AGL)

WARNING

If the aural command is not a climb, it indicates the TFR is receiving or interpreting the altitude incorrectly. TF should not be performed if switching LARA or TFR channels does not correct the command.

d. Radar altimeter control knob—Release.

e. Autopilot release lever or autopilot release/PCSS lever (as applicable)—Release.
(1) Fly-up maneuver—Initiated.

f. Autopilot release lever—Depressed. (Prior to T.O. 1F-111(B)A-593)

g. Autopilot release/PCSS lever—Depress and hold to first detent. (After T.O. 1F-111(B)A-593)

h. Radar altitude bypass switch—BYPASS.

i. Autopilot release lever or autopilot release/PCSS lever (as applicable)—Release.

P 14. Auto TF switch—AUTO. (If desired)
Leave the auto TF switch OFF for Oil Burner entry. The reference or ATF not engaged light (as applicable) will be lighted during the time the auto TF switch is OFF. If the autopilot submodes are being used i.e., HDG/NAV, monitor the aircraft closely to insure the aircraft is following steering commands.

Note

- The pitch trim function of the stick trim button is deactivated when auto TF is engaged. A slight pitch transient may be felt when auto TF is engaged if the parallel pitch trim actuator is not at take off trim due to normal system tolerances.
- If a flyup is commanded due to rain during the letdown, the pilot should depress the autopilot release lever prior to T.O. 1F-111(B)A-593, or depress to the first detent the autopilot release/PCSS lever after T.O. 1F-111(B)A-593, establish a 10 degree dive angle, and continue a manual letdown until 1000 feet above the MEA. At this time, he should decrease the dive angle to 2 degrees and level off at the desired MEA. The letdown to 1000 feet, and subsequently lower settings, can be resumed as the rain return disappears from the E scope.

♦**P** 15. Wing sweep—As required.
The wing sweep for Auto TF Letdown will normally be that computed for low altitude operation. Avoid high angles-of-attack with aft wing sweeps prior to initiating descent. In cases of high altitude and/or low airspeed, wing sweep should be delayed until descent has been initiated.

P 16. ADI and ODS pitch steering bars—Centered. (Auto TF letdown)

♦ 17. Altitude calls—Accomplished.
The navigator will announce the altitude calls when crossing 15,000, 10,000 and 5,000 feet MSL. He will also notify the pilot 1,000 feet above initial level off.

P 18. At 5,000 feet above the terrain: (If applicable)
a. Radar altimeter bypass switch—NORMAL.
b. Dive angle increase to 12 degrees.

♦ 19. Altitude calibration—Completed.
If terrain conditions permit an accurate calibration.

♦**B** 20. Altimeters crosschecked—Accomplished.
Crosscheck AVVI, standby altimeter and radar altimeter.

♦**B** 21. Level off—Monitored.
During auto and manual TF letdown a climb command should be indicated on the ADI/ODS command bars at approximately 2000 feet AGL and aircraft rotation toward level flight should begin no later than 1600 feet AGL.

♦**B** 22. Helmet visors—Lowered. (As practicable)

Note

Whenever practical the flight crew shall lower helmet visors for protection against bird strikes and possible windshield failure.

♦**P** 23. Wing sweep—Set.

P 24. Auto TF switch—AUTO. (As required)

P 25. 1000 foot check:
a. Terrain clearance—Checked. (900 to 1200 feet).
Use the radar altimeter to check the terrain clearance.
b. E scope display—Checked.
Check video positioning relative to command line.

26. 83% fly-up—Checked.
This check should be performed over level terrain or water if possible.
a. Radar altimeter index pointer—Set 830 feet.
b. Clearance plane—Set 500 feet.

c. Radar altitude low warning lamp—Lighted, passing 830 feet.
   Aircraft should level within limits of 500 foot setting. (440-650 feet)
d. Fly-up initiated.
   Set 1000 feet clearance plane after pausing momentarily at 750 foot setting.
   (1) TF failure warning lamp—Lighted until aircraft passes through 830 feet absolute.
   (2) ADI/ODS—Indicate fly-up.
       The pitch steering bars on the ADI/ODS will indicate a fly-up until the TF fail clears, then indicate normally.
   (3) Aural command—Full climb.
   (4) Radar altitude low warning lamp—Out at 830 feet.
   (5) Autopilot release lever — Depress and hold, then release. (Prior to T.O. 1F-111(B)A-593)
       Depress lever and hold while leveling aircraft at 1000 feet, then release.
   (6) Autopilot release/PCSS lever—Depress and hold to first detent, then release. (After T.O. 1F-111(B)A-593)
       Depress lever and hold while leveling aircraft at 1000 feet, then release.
   (7) Aircraft levels at 1000 feet.
   (8) Radar altimeter channel select switch—Opposite channel.
   (9) Repeat substeps b through d.

WARNING

If the 83% fly-up capability is not operational in a radar altimeter channel, do not use that channel for TF operation.

27. Terrain clearance knob—Set as briefed.
28. Radar altimeter—Reset to 83 percent of clearance plane.
29. L or R TFR channel mode selector knob—SIT or GM.

WARNING

Airspeed should be held to mach 0.85 or less when the 500 foot position, WX mode, is selected. If this airspeed is exceeded, the TFR will not anticipate the terrain early enough to provide a command to prevent terrain impact.

Note

TF fly-up fail is caused by one of several conditions. Refer to "TF Fly-up Causes," this section.

TFR INFLIGHT OPERATIONAL CHECK. (AFTER T.O. 1F-111-996)

This check is required only if the TFR ground check was not performed. This check must be accomplished at an altitude above 5000 feet AGL to obtain specified indications.

1. Wing sweep—As required.
2. Radar altimeter index pointer—Set 200 feet.
3. Terrain clearance knob—Set 800 feet.
4. Ride control—MED.
5. TFR channel mode selector knobs—L TF, R SIT.
   a. TFR channel fail caution lamps—Lighted.
   b. Reference not engaged caution lamp—Lighted.
   c. TF fly-up off caution lamp—Lighted.
   d. TF failure warning lamp—Lighted.
   e. Radar altitude low warning lamp—Out.
6. ISC pitch steering mode switch—TF.
7. Radar altimeter bypass switch—BYPASS.
8. Radar altimeter control knob—Depress and hold.
   a. Radar altimeter bypass switch—Returns to NORMAL.
   b. Radar altimeter—300 (±15) feet.
   c. TF failure warning lamp—Out.
   d. TFR channel fail caution lamps—Out.
   e. Radar altitude low warning lamp—Out.
   f. TF fly-up off caution lamp—Out.
   g. Pitch steering bars and aural command indicate a slight dive command (if level flight).
9. Auto TF switch—AUTO TF.
   Aircraft establishes a slight dive.
10. Terrain clearance knob—Set 300 feet.
    a. Pitch steering bars and aural command—Approximately nulled (if level flight).
    b. Aircraft establishes level flight.
11. Terrain clearance knob—Set 400 feet.
    a. Aircraft response—Fly-up.
    b. TF failure warning lamp—Lighted.
    c. TFR channel fail caution lamp—Lighted, for channel in TF mode.
    d. Radar altitude low warning lamp—Lighted.
    e. Pitch steering bars and aural command indicate maximum climb command.

12. Radar altimeter control knob—Released.
13. Autopilot release lever—Depress and hold. (Prior to T.O. 1F-111(B)A-593)
14. Autopilot release/PCSS lever—Depress and hold to first detent. (After T.O. 1F-111(B)A-593)
15. Radar altimeter bypass switch—BYPASS.
16. Autopilot release lever or autopilot release/ PCSS lever (as applicable)—Release.
17. Auto TF switch—OFF.
18. E scope—Checked.
    Check self-test pulse and zero command line.

WARNING

If the self-test pulse is absent, do not fly TF under night or IFR conditions.

19. Repeat steps 3 thru 18 with TFR and radar altimeter channels reversed.
20. TFR L and R channel mode selector knobs—TF.

PREDESCENT AND DESCENT (LOW ALTITUDE TACTICAL OPERATION). (AFTER T.O. 1F-111-996)

If TFR is not to be performed, only the ◆ steps must be accomplished. Auto/manual TF letdown will be made from cruise mach, throttles and airspeed as required. Non-TF descents will be made at cruise mach until intercepting the indicated airspeed that corresponds to the desired low level mach .Adjust to low level mach after level off.

B 1. TFR operational check—Completed. (Ground or inflight)
◆B 2. Fuel panel—Checked.
◆P 3. Engine inlet anti-icing—Climatic.
◆B 4. Altimeters—Reset. (If required)
◆ 5. IFF—Set.
◆P 6. AMI and AVVI command markers and ODS indicated airspeed—Set to desired airspeed and altitude.
◆P 7. Radar altimeter—Set as briefed.
8. TFR switches—Set.
   a. Range selector knob—E position.
   b. Ride control knob—As desired.
   c. Volume control knob—As desired.
   d. Terrain clearance knob—1000 feet.
B 9. ILS communications monitor knob—As desired. (After T.O. 1F-111-1074)
P10. Radar altimeter bypass switch—BYPASS.
B11. L and R TFR channel mode selector knobs—TF.
P12. Reference or ATF not engaged lamp (as applicable)—Lighted.
P13. Pitch steering mode selector switch—TF.
   a. ADI and ODS pitch steering bars—Indicate dive.
   b. Aural command—Dive.
   c. TF failure warning and channel fail lamps—Out.
   d. E scope—Checked.
      Check self-test pulse and zero command line.

WARNING

If the self-test pulse is absent, do not fly TF under night or IFR conditions.

B14. Fly-up check—Complete.

Note

This check is optional if the inflight operational check has been accomplished.

   a. Terrain clearance knob—Set 400 feet.
   b. Autopilot release lever — Hold depressed. (Prior to T.O. 1F-111(B)A-593)
   c. Autopilot release/PCSS lever—Depress and hold to first detent. (After T.O. 1F-111(B)A-593)
   d. Radar altimeter control knob—Depress and hold.
      (1) Bypass switch—Return to normal.
      (2) Off warning flag—Out of view.
      (3) Indicator pointer—300 (±15) feet.
      (4) TFR failure warning and channel fail caution lamps—Lighted.
      (5) ADI and ODS pitch steering bars—Full fly-up command.
      (6) Aural command—Full climb. (If above 5000 feet AGL)
   e. Autopilot release lever or autopilot release/ PCSS lever (as applicable)—Release.
      (1) Fly up maneuver—Initiated.
   f. Autopilot release lever—Depressed. (Prior to T.O. 1F-111(B)A-593)
   g. Autopilot release/PCSS lever—Depress and hold to first detent. (After T.O. 1F-111(B)A-593)
   h. Radar altimeter control knob—Release.
   i. Radar altitude bypass switch—BYPASS.

j. Autopilot release lever or autopilot release/PCSS lever (as applicable)—Release.
k. Terrain clearance knob—Set 1000 feet.

P15. Auto TF switch—AUTO. (If desired)
Leave the auto TF switch off for Oil Burner Entry. The reference or ATF not engaged lamp (as applicable) will be lighted during the time the auto TF switch is off. If autopilot sub-modes are being used i.e., HDG/NAV, monitor the aircraft closely to ensure the aircraft is following steering commands.

Note

- The pitch trim function of the stick trim button is deactivated when auto TF is engaged. A slight pitch transient may be felt when auto TF is engaged if the parallel pitch trim actuator is not at take off trim due to normal system tolerances.
- If a fly-up is commanded due to rain during the letdown, the pilot should depress the autopilot release lever prior to T.O. 1F-111(B)A-593 or depress to the first detent the autopilot release/PCSS lever after T.O. 1F-111(B)A-593, establish a 10 degree dive angle, and continue a manual letdown until 1000 feet above the MEA. At this time, he should decrease the dive angle to 2 degrees and level off at the desired MEA. The letdown to 1000 feet, and subsequently lower settings, can be resumed as the rain return disappears from the E-scope.

P16. Wing sweep—As required.
The wing sweep for auto TF letdown will normally be that computed for low altitude operation. Avoid high angles-of-attack with aft wing sweeps prior to initiating descent. In cases of high altitude and/or low airspeed, wing sweep should be delayed until descent has been initiated.

P17. ADI and ODS pitch steering bars—Centered. (Auto TF letdown)

◆ 18. Altitude calls—Accomplished.
The navigator will announce the altitude calls when crossing 15,000, 10,000 and 5,000 feet MSL. He will also notify the pilot 1000 feet above initial level off.

P19. At 5000 feet above the terrain:
(If applicable)
a. Radar altimeter bypass switch—NORMAL.
b. Dive angle increase to 12 degrees.

◆ 20. Altitude calibration—Completed.
If terrain conditions permit an accurate calibration.

◆B21. Altimeters crosschecked—Accomplished.
Crosscheck AVVI, standby altimeter and radar altimeter.

◆B22. Level off—Monitored.
During auto and manual TF letdown a climb command should be indicated on the ADI/ODS command bars at approximately 2000 feet AGL and aircraft rotation toward level flight should begin no later than 1600 feet AGL.

◆B23. Helmet visors—Lowered. (As practicable)

Note

Whenever practical the flight crew shall lower helmet visors for protection against bird strikes which might cause windshield failure when at low altitude.

◆P24. Wing sweep—Set.

P25. Auto TF switch—AUTO. (As required)

P26. 1000 foot check:
a. Terrain clearance—Checked. (900 to 1200 feet)
Use the radar altimeter to check the terrain clearance.
b. E scope display—Checked.
Check video positioning relative to command line.

27. 83% fly-up—Checked.
This check should be performed over level terrain or water if possible.
a. Radar altimeter index pointer—Set 830 feet.
b. Clearance plane—Set 500 feet.
c. Radar altitude low warning lamp—Lighted, passing 830 feet.
Aircraft should level within limits of 500 foot setting. (440-650 feet)
d. Fly-up—Initiated.
Set 1000 feet clearance plane after pausing momentarily at 750 foot setting.
(1) TF failure warning lamp—Lighted until aircraft passes through 830 feet absolute.
(2) ADI/ODS—Indicate fly-up.
The pitch steering bars on the ADI/ODS will indicate a fly-up until the TF fail clears, then indicate normally.
(3) Aural command—Full climb.
(4) Radar altitude low warning lamp—Out at 830 feet.
(5) Autopilot release lever—Depress and hold, then release. (Prior to T.O. 1F-111(B)A-593)
Depress lever and hold while leveling aircraft at 1000 feet, then release.

(6) Autopilot release/PCSS lever—Depress and hold to first detent, then release. (After T.O. 1F-111(B)A-593)
Depress lever and hold while leveling aircraft at 1000 feet, then release.

(7) Aircraft levels at 1000 feet.

(8) Radar altimeter channel selector switch —Opposite channel.

(9) Repeat substeps b through d.

WARNING

If the 83% fly-up capability is not operational in a radar altimeter channel, do not use that channel for TF operation.

28. Terrain clearance knob—Set as briefed.
29. Radar altimeter—Reset to 83 percent of clearance plane.
30. L or R TFR channel mode selector knob—SIT or GM.

WARNING

Airspeed should be held to mach 0.85 or less when the 500 foot position, WX mode, is selected. If this airspeed is exceeded, the TFR will not anticipate the terrain early enough to provide a command to prevent terrain impact.

CONVENTIONAL MUNITIONS PREARMING.

Note

Perform this checklist within 15 minutes prior to the IP for high altitude deliveries or within 15 minutes prior to the descent to low altitude for low altitude deliveries unless otherwise specified in the operation order.

1. Stores control panel:
   a. Master switch—ON.
   b. Selector mode knob—STA JETT.
   c. Station select lamps—Out.
   If any station select lamp is on, deselect station.
   d. Test button—Depressed.
   Station select lamps should be lighted at all loaded stations, all others off.
   e. Selector mode knob—As briefed.
   f. Test button—Depressed.
   Station select lamps should be lighted at weapon loaded stations. All other station select lamps should be off.

WARNING

On normal training sorties with external fuel tanks loaded, if any abnormal station select lamp indications are noted perform "Abort Mission Procedures" check and do not attempt any practice bombing activity.

   g. Bomb arm switch—As briefed.
   h. Interval counter—As briefed.
   i. Station select switches—Selected.
   j. Station select lamps—Lighted.
   k. Master switch—OFF.

PRE BOMB.

Accomplish the following checklist prior to reaching each IP. In event an IP is not designated, complete this checklist in sufficient time to accomplish the bomb run.

1. Altitude calibration—Completed.
B 2. Altitude—Set as required.
3. UHF #1 radio—Set as briefed. (RBS only)
P 4. Optical display system mode knob—CMD. (If required)
P 5. Bombing timer—Set. (If applicable)
P 6. Bombing timer power selector knob—ON. (If applicable)
7. Manual ballistics—Set.
Set manual ballistics from data computed on bombing data form.
8. Penetration aids system—On and set.
9. Bomb run timing/heading/altitude—Verified.
Advise the pilot of the time and altitude to the first release and the magnetic course/heading, time and altitude between multiple releases.
10. Stores control panel:
   a. Interval counter—As briefed.
   b. Selector mode knob—As briefed.
11. Alternate release data—Determined.
Determine TG from the applicable timing point using best known ground speed and bombing altitude.

SYNCHRONOUS BOMB RUN.

Accomplish this checklist after sequencing to the target.

WARNING

To prevent release or to stop an initiated release, immediately position the delivery mode knob to OFF. If no further releases are to be attempted, proceed to "Abort Mission Procedures".

P 1. ISC switch—BOMB/NAV.

2. Selected sequence point pushbutton—TARGET.
3. Sequence number set wheels—Set to next target or destination.

† **P** 4. Nuclear consent switch—REL ONLY. (As applicable) (MAU-12 single carriage)

Note

When releases are to be made on a designated bombing range do not perform this step until the aircraft is over the range.

5. Stores control panel:
   a. Master switch—ON.
   b. Station select lamps—Lighted.
      Check that station select lamps for selected stations are lighted, all others out.
   c. Stores control panel test button—Depressed, station select lamps lighted at weapon simulated loaded stations; all others out.

WARNING

On normal training sorties with external fuel tanks loaded, if any abnormal station select lamp indications are noted, place the master switch OFF, perform "Abort Mission Procedures" and do not attempt any practice bombing activity.

6. Function select knob—RADAR BOMB/VISUAL BOMB.

Note

If utilizing a pseudo target, do not complete the following items until past the pseudo target.

7. Bay door control switch—As required.

Note

- When using AUX (auxiliary bay door power), manual operation of the doors is required. AUTO (automatic door opening) may inhibit bomb release due to excessive door opening time.
- For manual door opening, position the bay door control switch to OPEN approximately 60 seconds prior to release.
- For external bomb release, position the bay door control switch to CLOSE. For internal release with the delivery mode knob in AUX the bay door switch must be in OPEN.

As Reqd 15-7

8. Release enable switch—~~RELEASE ENABLE.~~
9. Delivery mode knob—BOMB. WARNING 15-7

WARNING

The delivery mode knob must be left in the OFF position until after passing the pseudo target to preclude inadvertent release.

10. Bomb away:

B a. Lamps—Checked.
The pilot's and navigator's bomb release lamps will light when a release signal is present. This release signal will normally be present for approximately 3 seconds prior to T.O 1F-111(B)A-651. After T.O. 1F-111(B)A-651, the release signal will be present for approximately 1 second and the navigator's bomb release lamp will

remain lighted for an additional 2 seconds after the release signal is removed. In either configuration, the station selected and stores present lamp and all DCU-137/A lamps will go out when the bomb is released.

WARNING

- Do not operate any of the bombing system controls, except as noted below, when a release signal is present as indicated by the pilot's bomb release lamp. Operation of the master switch, station select switches, monitor and release knob, delivery mode knob or selector mode knob during presence of a release signal (normally 3 seconds prior to T.O. 1F-111(B)A-651; 1 second after T.O. 1F-111(B)A-651) may result in inadvertent store or bomb rack release.
- On normal training sorties, if the pilot's bomb release lamp remains lighted for an indefinite period of time (approximately 5 seconds or more after last intended release prior to T.O. 1F-111(B)A-651; 3 seconds or more after T.O. 1F-111(B)A-651) place the delivery mode knob OFF, selector mode knob OFF, and master switch OFF, in that sequence, perform "Abort Mission Procedures," this section, and do not attempt any practice bombing activity.

Note

If there was no automatic release at TG zero, place the delivery mode knob to AUX, bay door control switch to OPEN (internal release), and depress the weapon release button.

ALTERNATE BOMB RUN.

This checklist should commence after passing last destination prior to target.

WARNING

To prevent release or to stop an initiated release, immediately position the delivery mode knob to OFF. If no further releases are to be attempted, proceed to "Abort Mission Procedures".

P 1. ODS mode select knob—As required.

†**P** 2. Nuclear consent switch—*REL ONLY*. (As applicable) (MAU-12 single carriage)

Note

When releases are to be made on a designated bombing range, do not perform this step until the aircraft is over the bombing range.

3. Stores control panel:
   a. Master switch—ON.
   b. Station select lamps—Lighted.
      Check that station select lamps for selected stations are lighted, all others out.
   c. Stores control panel test button—Depressed, station select lamps lighted at weapon simulated loaded stations; all others out (RBS only).

WARNING

On normal training sorties with external fuel tanks loaded, if any abnormal station select lamp indications are noted, place the master switch OFF, perform "Abort Mission Procedures" and do not attempt any practice bombing activity.

   d. Bay door control switch—OPEN. (If required)
      Position the bay door control switch to OPEN approximately 60 seconds prior to release.

Note

If using auxiliary power the bay doors may require up to a maximum of 30 seconds to open.

15-7

   e. Delivery mode knob—AUX. As Req'd
   f. Release enable switch—~~RELEASE ENABLE~~
      WARNING 15-7
4. Bomb away:
   a. Weapon release button—Depressed.
   B b. Lamps—Checked.
      When the weapon release button is depressed, weapon release is commanded to the station and the pilot's weapon release lamp is lighted. The release lamp will remain lighted as long as the weapon release button is held depressed. The station selected and stores present lamp and all DCU-137/A lamps will go out when the bomb is released.

WARNING

- Do not operate any of the bombing system controls, except as noted below, when a release signal is present as indicated by the pilot's bomb release lamp. Operation of the master switch, station select switches, monitor and release knob, delivery mode knob, or selector mode knob during presence of a release signal (weapon release button depressed) may result in inadvertent store or bomb rack release.
- On normal training sorties, if the pilot's bomb release lamp remains lighted after the weapon release button is released, place the delivery mode knob OFF, selector mode knob OFF, and master switch OFF, in that sequence, perform "Abort Mission Procedures," this section, and do not attempt any practice bombing activity.

POST RELEASE.

Accomplish the following checks after each release:

†P 1. Nuclear consent switch—OFF. (As applicable) (MAU-12 single carriage)
2. Stores control panel:
   a. Release enable switch—INHIBIT.
   b. Bay door control switch—CLOSE.
   c. Delivery mode knob—OFF.
   d. Selector mode knob—OFF.
   e. Master switch—OFF.
3. Bombing timer power selector knob—OFF.

P 4. Constant track/heading nav switch—As desired.
5. Selected sequence point pushbuttons—As desired.
6. Function select switch—NAV
7. ECM control knobs (3)—REC. (RBS only)
8. Attack radar tracking handle—Wide sector.

Note

(EWO only) After all external stores have been released, bomb pylons may be jettisoned to reduce drag.

ABORT MISSION PROCEDURES.

1. Stores control panel:
   a. Release enable switch—INHIBIT.
   b. Station select switches—Deselected.
   c. Master switch—OFF.
   d. Selector mode knob—OFF.
   e. Delivery mode knob—OFF.
   f. Bay door control switch—CLOSE.

†P 2. Nuclear consent switch—OFF. (As applicable) (MAU-12 single carriage)

DESCENT, LANDING, AND POSTFLIGHT PROCEDURES.

1. Accomplish the checklists and procedures as outlined in Section II.

HF COMMUNICATION SYSTEM OPERATION.

WARNING

Ensure that no personnel or equipment remain in the vicinity of the vertical fin or dorsal antenna sections while the HF radio is transmitting. Be sure that no fuel, oil, or oxygen carts are connected to the aircraft while operating the HF radio. Refer to Section II for danger areas.

Note

- If ground operation of the HF system is required, electromagnetic radiation may produce excessive harmonic distortion in the external power monitor, resulting in the power monitor rejecting ground power. Should this occur the external power switch should be selected to OFF and then OVRD.
- Electromagnetic interference from HF radio transmission, on some frequencies, may cause a fly-up maneuver when operating the TFR in the TF mode. This interference may also cause degradation of the TFR scope displays. If HF radio use is essential and interference is noted when operating in the TF mode, the terrain should be cleared visually or, if this is not possible, the aircraft climbed to the minimum enroute altitude.

1. Transmitter selector knob—HF.
2. HF monitor knob—On.
3. Mode selector knob—Desired mode.
4. Volume control—Adjusted.
   Adjust volume control to obtain audio balance between HF and UHF radios.
5. RF gain control knob—Maximum clockwise.
6. Squelch control knob—Maximum clockwise.
7. Desired frequency—Set.
8. Microphone switch—TRANS.
   After a frequency change, a 1 kilohertz tone will be heard when the microphone switch is first placed to TRANS. This indicates that

the amplifier power supply unit and antenna coupler are tuning. When the tone ceases, the tuning cycle is complete and a sidetone will be heard when transmitting. Lack of sidetone indicates coupler mistune or an incorrect adjustment of the volume control knob.

9. RF gain control knob—Adjusted.
   Establish contact and then adjust RF GAIN control knob to obtain optimum signal to noise ratio.

Note

If receiver operation is unsatisfactory, rotate the volume control, RF gain control, and squelch control knobs to the maximum clockwise position.

GROUND ALIGNMENT. (ALTERNATE)

Alignment to Stored Heading.

Note

- For an accurate stored heading the INS must have undergone an accurate gyrocompass alignment and the aircraft must not have been moved since the system was turned off.
- Placing the Function select knob to NAV momentarily after the gyrocompass alignment will improve the subsequent stored heading alignment.

1. INS ground align knob—STRD HDG.
2. General navigation computer switch—GNC.
3. Weapons delivery computer switch—WDC.
4. Function select knob—GND ALIGN.
   Check that the INS heat lamp comes on immediately after entering the ground align mode. The align lamp should light steady within 1½ minutes after going to the align mode.
5. Align lamp—Flashing.
   This completes the alignment mode.

Alignment To Stored Magnetic Variation.

Note

- For an accurate stored magnetic variation alignment the INS must have undergone an accurate gyrocompass alignment (not a two axis trim) and the aircraft, if moved, must be returned to within 2.5 degrees of original heading, and the magnetic variation must have remained essentially unchanged.
- Placing the function select knob to NAV momentarily after the gyrocompass alignment will improve the subsequent stored magnetic variation alignment.

1. INS ground align knob—MAG HDG.
2. General navigation computer switch—GNC.
3. Weapons delivery computer switch—WDC.
4. Function select knob—GND ALIGN.
   Check that INS heat lamp lights immediately after entering the ground align mode. The align lamp should light steady within 1½ minutes after going to the align mode.
5. Align lamp—Flashing.
   This completes the alignment mode.

TWO AXIS TRIM ALIGNMENT PROCEDURE.

1. INS ground align knob—TRIM.
2. General navigation computer switch—GNC.
3. Weapons delivery computer switch—WDC.
4. Function select knob—GND ALIGN.
   Check that INS heat lamp lights immediately after entering the ground align mode. The align lamp should light steady within 1½ minutes after going to the align mode. The align lamp will flash for 20 seconds after completion of the first gyrocompass alignment. If NAV mode is not selected during this 20 second interval, the stable element will be slewed 90 degrees and the second gyrocompass alignment will be initiated. The align lamp will remain out during this alignment. Upon completion of the second gyrocompass alignment (approximately 9 minutes) the align lamp will begin flashing.
5. Data switch—ENTRY.
   Enter coordinates and mag var of the aircraft location behind data number 000.
6. INS reset button—Depress.
   If the align lamp is on, it will go out for approximately 90 seconds and then come on.
7. Align lamp—Flashing.
   This completes the alignment mode.

DCC RECOVERY AND INS INFLIGHT ALIGNMENT.

1. TAS mode recovery:
   a. NAV mode select pushbutton—TAS selected. (All other modes deselected)
   b. INS ground align knob—OFF.
      Insure that the TAS advisory light only is lighted.
   c. Flight instrument reference switch—AUX.
      Manual steering is required until the system is recovered.

d. Heading cross-check—Accomplished.
Insure AFRS heading is slaved and synchronized, cross-check headings with the standby magnetic compass.

e. Function select knob—GND ALIGN.
The present position displays will revert to the coordinates in data number 00.

f. Data entry—Accomplished and verified.

(1) Data switch—ENTRY.

(2) Data number—Enter 00.

(3) Latitude/longitude — Enter to nearest 0.01.
Enter the coordinates of the planned point to be overflown.

(4) MAG VAR—Enter to nearest 0.1.

(5) Wind SPD and DIR—Entered and verified on NDU.

g. Function select knob—NAV.
When the aircraft is over the selected point, place the function select knob to NAV and verify the present position is driving.

h. Present position—Updated as required.
Use cursor drift as a guide to determine system accuracy. In the TAS mode, frequent present position corrections must be accomplished following a change in heading, altitude, or wind. Special emphasis must be given to manually entered winds, MAG VAR, and multiple present position corrections on the same fixpoint.

Note

If acceptable navigation data cannot be maintained, turn off the GNC and manually enter the best known wind and MAG VAR.

2. Doppler mode recovery:

a. NAV mode select pushbutton—D selected. (All other modes deselected)

b. INS ground align knob—OFF.

c. Flight instrument reference switch—AUX.
Manual steering is required until the system is recovered.

d. Heading cross-check—Accomplished.
Insure AFRS heading is slaved and synchronized, cross-check headings with the standby magnetic compass.

e. Function select knob—GND ALIGN.
The present position displays will revert to the coordinates in data number 00.

f. Data entry—Accomplished and verified.

(1) Data switch—ENTRY.

(2) Data number—Enter 00.

(3) Latitude/longitude — Enter to nearest 0.01.
Enter the coordinates of the planned point to be overflown.

(4) MAG VAR—Enter to nearest 0.1.

(5) Wind SPD and DIR—Checked on NDU.
Insure DCO lamp out, D advisory lamp lighted. If doppler information is invalid, use the TAS mode recovery in the previous step.

g. Function select knob—NAV.
When the aircraft is over the selected point, place the function select knob to NAV and verify the present position is driving.

h. Present position—Update as required.
Use cursor drift as a guide to determine system accuracy. In the doppler mode, frequent present position corrections must be accomplished. Special emphasis must be given to manually entered MAG VAR.

Note

If acceptable navigation data cannot be maintained, turn the GNC off, check heading and MAG VAR. If navigation data is still unacceptable, deselect doppler, select TAS, and reenter wind and MAG VAR.

3. If INS inflight alignment is desired:
The INS will not align inflight without the GNC or WDC on and operational.

a. INS ground align knob—OFF, for 30 seconds.

b. I nav mode pushbutton—Selected.

c. INS ground align knob—G/C (Remain straight and level for 45 seconds)

d. INS align lamp—Lighted.
The align lamp will not light unless the INS ground align knob has been recycled.

e. Primary attitude/heading caution lamps — Out. (When the I nav mode lamp lights)
If the primary attitude caution lamp lights, check that the flight instrument reference selector is in primary.

f. Present position—Updated as necessary.

g. INS align lamp—Out. (When alignment is complete)
It is not necessary to maintain straight and level flight after the first 45 seconds; however, doppler attitude limits (28 degrees roll and 18 degrees pitch) should be observed and turns may improve the alignment. Alignment time will vary greatly depending on flight path, the ve-

locity reference being used, the number of updates performed and the time between each.

4. Nav mode select pushbuttons—As desired.

DATA ENTRY.

1. Data switch—ENTRY.
2. Address select switch—Set.
   Position the address selector knob to the type of data to be entered. If the address select switch number 2 must be used, position the address select switch number 1 to the (ARROW) ➧ position.
3. Clear pushbutton—Depress.
4. Data entry pushbuttons—Enter data.
   Check that the proper data is displayed on the data storage/data number display.
5. Enter pushbutton—Depress.
   Check that the data storage/data number display goes blank and the entered data reappears.

Note

Data entry cannot be performed if the ALT CAL pushbutton was depressed when the DCC was powered up.

SEQUENCE NUMBER ENTRY.

1. Sequence number set wheels—Set.
2. Selected sequence point pushbutton — Depressed.
3. Data switch—SEQ.
4. Clear pushbutton—Depress.
5. Data entry pushbuttons—Enter data number.
   Verify the data number is correct; if not depress the CLR pushbutton and re-enter the data.
6. Enter pushbutton—Depress.
   The data number will go blank momentarily and the data number will reappear.
7. *Data number counter—Check for correct data* number.
8. Data storage counter—Check for correct sequence number.

SEQUENCE NUMBER VERIFICATION.

1. Sequence number set wheels—Set.
2. Manual sequence and display pushbutton—Depress.
3. Selected sequence point pushbutton—Depressed.
   Verify correct sequence point display on selected sequence point counters.

WEAPONS LOCATION AND ID VERIFICATION.

1. Data number—Entered.
   Enter the data number for the first weapon location.
2. Address select number 1—Arrow position ➧.
3. Address select number 2—WPN LOC and ID.
4. Data switch—DISP.
5. Data storage display—Verified.
   Check that the seven digit number in the data storage window agrees with the SAC Form 264. Repeat steps 1 through 5 for each weapon.

DATA POINT VERIFICATION.

1. Data switch—ENTRY.
2. Address select number 1—DATA NO.
3. Clear pushbutton—Depress.
4. Data entry pushbuttons—Enter data number.
   Observe correct data number on data number counter.
5. Enter pushbutton—Depress.
   Observe data number counter blanks and data number reappears.
6. Data switch—DISP.
7. Address select number 1—LAT.
   Verify that correct latitude is displayed on data storage counter.
8. Address select number 1—LONG.
   Verify that correct longitude is displayed on the data storage counter.
9. Address select number 1—ELEV.
   Verify that correct elevation is displayed on the data storage counter.

SEQUENCE INTERRUPT.

1. Selected sequence point pushbutton—Depress.
2. Sequence number setwheels—Set as desired.
3. Sequence number select pushbutton—Depress.
   Verify the sequence number and coordinates are displayed correctly.

PRESENT POSITION CORRECTION–RADAR.

1. Function select knob—NAV or MANUAL.
2. Fix mode selector knob—RADAR FXPT or RADAR DEST.
3. Present position correction switch—IN.

Note

Cursor movement is not possible with present position switch out.

4. Radar mode selector knob—GND AUTO or GND VEL.
   Place cursors over selected point with the tracking control handle.
5. Fix mode switch—OFF.
   When the fix mode switch is rotated to OFF, corrections for present position update are sent to the DCC.
6. Present position correction switch—OUT.

PRESENT POSITION CORRECTION—VISUAL OVERFLY.

1. Function select knob—NAV or MANUAL.
2. Fix mode selector knob—VISUAL OVERFLY.
3. Destination or fixpoint pushbutton—Depressed.
   If a target is utilized, the function select knob must be in NAV and the destination pushbutton must be depressed.
4. Sequence interrupt—Accomplished.
   Interrupt to a programmed destination, fixpoint, or target. Manual entry of destination or fixpoint coordinate data may be accomplished in lieu of the sequence interrupt to a planned point. Do not depress manual sequence and display.
5. Wind and mag var—Entered. (As required)
6. EVF pushbutton—Depressed at time of overfly.
   Only the first actuation of the EVF switch will be accepted by the computer complex. If the visual overfly was not accepted, complete item 7 and reaccomplish entire procedure above.
7. Fix mode selector knob—OFF.

PRESENT POSITION CORRECTION—VISUAL AUTOMATIC.

1. Select sequence point pushbutton — Depress DEST or FXPT as desired.
2. Fix mode selector knob—VISUAL AUTO.
3. ODS mode select knob—CMD.
4. Aiming reticle cage lever—Uncaged.
5. EVF pushbutton—Depress at time of ODS reticle coincidence on selected DEST/FXPT.
6. Fix mode selector knob—OFF.

PRESENT POSITION CORRECTION—INS AUTONOMOUS.

1. Data switch—ENTRY.
2. Address select number 1—LAT, LONG.
3. Data entry pushbuttons—Enter latitude and longitude.
   Once the data entry button is depressed only MAG VAR is displayed in the data storage window.
4. INS reset button—Depressed. (When over fixpoint)
   The coordinates will appear in the NDU present position display when the INS reset button is depressed.

FIXPOINT IDENTIFICATION—RADAR.

1. Function select knob—NAV.
2. Selected sequence point pushbutton—FXPT ID.
3. Fix mode selector knob — RADAR FXPT or RADAR DEST.
4. Radar mode selector knob—GND AUTO or GND VEL.
5. Attack radar tracking control handle—Place cursors over selected point.
6. Fix mode selector knob—OFF.
7. Fixpoint identification selected sequence number—Recorded.

FIXPOINT IDENTIFICATION—VISUAL OVERFLY.

1. Function select knob—NAV.
2. Selected sequence point pushbutton—FXPT ID.
3. Fix mode selector knob—VISUAL OVERFLY.
4. EVF pushbutton—Depress at time of overfly.
5. Fix mode selector knob—OFF.
6. Fixpoint identification selected sequence number—Recorded.

FIXPOINT IDENTIFICATION—VISUAL AUTOMATIC.

1. Function select knob—NAV.
2. Selected sequence point pushbutton—FXPT ID.
3. Fix mode selector knob—VISUAL AUTO.
4. ODS mode selector—CMD.
5. Aiming reticle cage lever—Uncaged.
6. EVF pushbutton — Depress at time of reticle/target coincidence.
7. Fix mode selector knob—OFF.
8. Fixpoint identification selected sequence number—Recorded.

ALTITUDE CALIBRATE.

(Low Altitude)

Note

Do not attempt low altitude calibration when above 4800 feet above terrain.

1. Radar altimeter—On.
2. Altitude calibration pushbutton—Depressed.
   The READY light will come on.

3. Destruct data—Entered.
   Enter a series of nines until the data storage display is filled with nines. Upon entry, the data storage display will blank and then redisplay within 15 seconds.
4. Sequence interrupt to destination 01.
5. Data destruct—Verified.
   Use the sequence number verification checklist to verify that the mission data displays all zeros for destinations, targets, offsets, and fixpoints in the GNC (WDC off), then in the WDC (GNC off).

AVIONICS SYSTEMS LAMP ANALYSIS.

Note

When any test indicator lamp lights, attempt to reset. If reset is unsuccessful, accomplish a recycle. If the lamp lights again, refer to the "Avionics Systems Analysis," Figure 4-1.

A reset is defined as depressing the avionics lamp twice for a single reported malfunction, or three times for two reported malfunctions, etc., and the lamp remaining out. A recycle is defined as removing power from the applicable system, i.e., GNC/WDC off then GNC, WDC simultaneously, ground align knob off then on, astro deselected then selected, or doppler deselected then selected as applicable.

Note

- Sound judgment should be exercised and all available indications checked before recycling a system for a reported malfunction. Indiscriminately recycling a system for a reported malfunction may not always be the best corrective action.
- INS power must be cycled in order to perform an in-flight alignment, refer to "DCC Initialization and INS Inflight Alignment."

TF FLY-UP CAUSES.

The TF fail fly up is caused by one of several conditions. These conditions are: (1) the TFR system detects an internal malfunction, (2) the TFR system detects an excessive error in comparison of certain inputs to the TFR, (3) the TFR system detects a loss of one or more input data good signals from other systems, and (4) altitude (AGL) is less than 83% of selected set clearance. Refer to figure 4-5 to determine TFR system indications of loss of good data signals.

This is the last page of Section IV.

SECTION V

OPERATING LIMITATIONS

Note

> The airspeed input provided to the airspeed mach indicator has been calibrated for pitot-static system errors by the CADC and therefore is actually KCAS (knots calibrated airspeed). However, this airspeed is referred to as KIAS (knots indicated airspeed) throughout this manual since it is read directly from the instrument.

TABLE OF CONTENTS.

INTRODUCTION

This section includes limitations that must be observed for safe and efficient operation of the engines and the aircraft. Special attention should be given to the instrument marking illustration (figure 5-1), since these limitations are not necessarily repeated under their respective sections. When necessary, an additional explanation of instrument markings is covered under appropriate headings.

Note

> The flight crew will make all necessary entries in Form 781 to indicate when any limitations have been exceeded. Entries shall include the time interval, where applicable, as well as the actual instrument reading value for the limitation that was exceeded.

The aircraft "g" load limitations contained herein are 80 percent of aircraft structural design limits.

MINIMUM CREW REQUIREMENTS.

The minimum crew for normal flight is two. The minimum crew for mission completion is two.

ENGINE LIMITATIONS.

GROUND OPERATION.

Engine idle speed:
Refer to figure 5-1.

Maximum IDLE time is unlimited.

Maximum time at MIL power—45 minutes.

Afterburner operating time limits:

AFTERBURNER	*ONE ENGINE See Note 1*	*BOTH ENGINES See Note 2*
Zone 1, 2, 3	6 Minutes	6 Minutes
Zone 4 & 5 (MAX)	90 Seconds	30 Seconds

CAUTION

1. Rudder must be deflected at least 11 degrees away from the operating afterburner when operating one engine in AB power.
2. Rudder must be centered when operating both engines in AB power.
3. Upon reaching any of the above limits, retard throttle(s) to MIL or below for 6 minutes before further AB operation. AB operation which includes a combination of any of the above conditions shall be limited to a total time of 6 minutes.

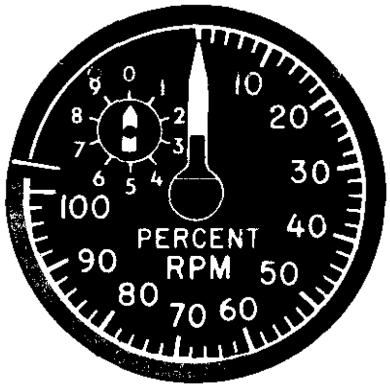
INFLIGHT OPERATION.

Engine operation should be conducted within the military rating and maximum rating time limits whenever practicable. However, if the mission or flight conditions require operation in excess of these time limits, thrust should not be reduced for only a short interval and then advanced to the high thrust level. Operation at the high thrust level should be continued until conditions permit a reduction in thrust. Overtime operation can be sustained without immediate adverse results, but the total operating life of the engine will be shortened. Operating continuously for one slightly longer period instead of using two or more shorter periods will avoid an additional heat cycling of the engine, which is detrimental to engine life.

Instrument Markings

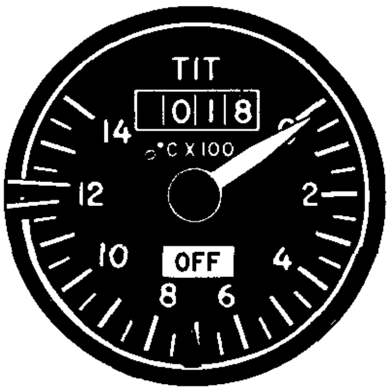
FUEL GRADE: JP-4
ENGINES: TF30-P-7

TACHOMETER



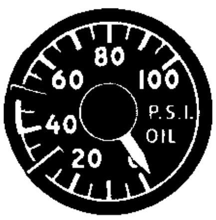
(Unmarked)	Engine idle speed—percent (Ground operation)	58 TO 71
	Normal operating range—percent	IDLE TO 103
	Maximum operating speed—percent	103

TURBINE INLET TEMPERATURE



		TEMPERATURE	TIME
	Normal operating range	300 TO 1177°C	SEE BELOW
▲	Starting: Gnd Start	710°C	MOMENTARY
	Airstart (Unmarked)	870°C	MAXIMUM
	Maximum Military operation	1177°C	45 MINUTES
	Maximum and Partial Afterburner Limit	1177°C	45 MINUTES
	During supersonic aircraft acceleration or during throttle transient (temperatures above 1177°C limited to 2 minutes).	1213°C	2 MINUTES
(Unmarked)	Maximum Continuous	1015°C	UNLIMITED

OIL PRESSURE

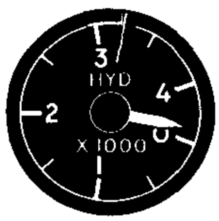


40 to 50 psi—Normal range.

30 psi—Minimum during idle.

50 psi—Maximum.

HYDRAULIC PRESSURE



2950 to 3250 psi—Normal range.

3250 psi—Maximum.

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Figure 5-1.

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The following limits for flight operation must be observed.

- Refer to figure 5-1 for turbine inlet temperature limitations.
- Turbine inlet temperature exceeding the value specified for *maximum continuous operation*—45 minutes.
- Afterburner operation—45 minutes.

ENGINE ACCELERATION LIMITS.

Refer to figure 5-1.

ENGINE OVERSPEED LIMIT.

Refer to figure 5-1.

ZERO "G" AND NEGATIVE "G" TIME LIMIT.

Engine Fuel Supply.

To prevent possible flameout of both engines, do not exceed 10 seconds under zero "g" or negative "g" flight conditions.

WARNING

Do not initiate a zero or negative "g" maneuver when the fuel low caution lamp is lighted. To do so could result in a flameout of both engines.

Note

The fuel low caution lamp may light during a negative "g" maneuver.

Oil Pressure.

The TF30 engine can be operated with zero indicated oil pressure for 60 seconds under zero "g" or negative "g" flight condition.

ALTERNATE FUEL.

Refer to figure 5-2 for specific limitations for alternate and emergency fuels.

Approved Fuels

	APPROVED/ALTERNATE FUELS					EMERGENCY FUEL
Fuel Specification	MIL-T-5624 Grade JP-4	1. MIL-T-5624 Grade JP-5 2. NATO F-44	1. ASTM D1655 Type A 2. NATO F-30	1. ASTM D1655 Type A-1 2. NATO F-34 or 35	1. ASTM D1655 Type B 2. NATO F-40	MIL-G-5572 Grade 115/145 Gasoline blended with 3 percent MIL-L-6082 Grade 1100 Petroleum Oil
Limitations	None	See Note A	See Note A for item 1	See Note A	See Note A	See Note B

Note A:

Since this fuel does not contain an anti-icing additive and the engines are not equipped with fuel heaters, an anti-icing additive must be blended with the fuel if extensive operation is to be performed where fuel temperatures may reach 0 degrees C or less. The additive will prevent ice from accumulating in the fuel controls and strainers.

Note B:

1. This fuel is approved for a one flight emergency situation only. An alternate fuel should be used if available.
2. Fuel tank pressurization selector switch must be selected to PRESSURIZE prior to take-off. The fuel tank pressurization caution lamp will be lighted when the landing gear is down or the refuel receptacle is extended.
3. Throttle movements should be as slow as practical.
4. Altitude should remain as low as practical and must not exceed 35,000 feet.
5. Engine thrust available may be reduced approximately 10 percent.
6. The aircraft should be filled with fuel at a temperature of less than 100 degrees F and maintained as cool as possible thereafter. Supersonic flight should be avoided.
7. It is permissible to mix this fuel with a preferred or alternate fuel in the aircraft. However the above restrictions are still applicable.

Figure 5-2.

OIL TEMPERATURE LIMITATIONS.

Maximum temperature is 120 degrees C (248 degrees F). ENG OIL HOT caution lamp will light when temperature value exceeds 121 degrees C (250 degrees F).

Note

Engine oil overheat may occur during supersonic operation with one engine at MIL or below since the cooling action of the AB fuel oil cooler is not available.

STARTER LIMITATIONS.

The starter is limited to 2 cartridge starts in a 15 minute period or 5 consecutive pneumatic starts after which a 1 hour cooling period must be observed. The starter is limited to the following periods of continuous operation after which a 15 minute cooling period must be observed:

Left Starter .... 10 minutes
Right Starter .... 2 minutes

AIRSPEED LIMITATIONS.

AIRSPEED AND ALTITUDE OPERATIONAL LIMIT ENVELOPES.

The airspeed restrictions for the aircraft with flaps retracted, gear up, and no external stores are presented in figure 5-3. With wings swept between 16 and 49 degrees the airspeed limits shown in figure 5-3 coincide with the limits programmed into the maximum safe mach assembly (MSMA). With the wings swept between 50 and 72.5 degrees the maximum airspeeds presented are permitted unless the maximum mach number would result in a total temperature greater than 153 degrees C (308 degrees F). In the event that the total temperature exceeds 153 degrees C, flight at the higher temperature is limited to five minutes per flight.

FUEL DUMP LIMIT SPEED.

Do not dump fuel at airspeeds above 350 KIAS or mach 0.75, whichever is less. To do so may cause dumped fuel to reenter the fuselage, resulting in a fire hazard.

Airspeed Limitations

DATA BASIS: FLIGHT TEST
DATE: 19 MAY 1972

CONFIGURATION:
GEAR UP
FLAPS/SLATS RETRACTED
NO EXTERNAL STORES

CONDITIONS:
STANDARD DAY

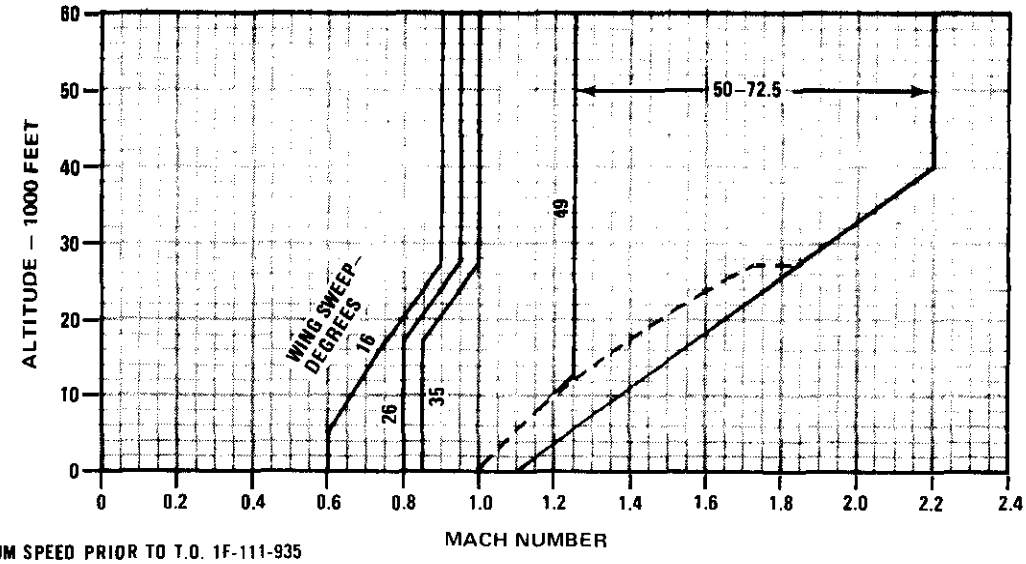

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Figure 5-3.

AIR REFUELING RECEPTACLE SPEED LIMIT.

Do not exceed 400 KIAS or mach 1.0, whichever is less, with the air refueling receptacle in any position other than fully closed.

SLATS/FLAPS LIMIT SPEEDS.

1. Flap limits are as follows:

During Extension

• Flaps—0 to 25 degrees	250 KIAS or 0.62 mach whichever is less
• Flaps—26 degrees to full down	220 KIAS or 0.48 mach, whichever is less

Static Extended Condition or During Retraction

• Flaps—0 to 25 degrees	270 KIAS or 0.62 mach whichever is less
• Flaps—26 degrees to full down	245 KIAS or 0.48 mach whichever is less

2. Slat limit speed is 295 KIAS or 0.62 mach whichever is less.

WARNING

Attempting abrupt rolling maneuvers or bank angles in excess of 60 degrees can result in loss of control of the aircraft since the flight control system is switched to T.O. & Land configuration by extension of the slats.

WEAPONS BAY DOORS.

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1. Do not open weapons bay doors at airspeeds in excess of mach 2.0 or exceed mach 2.0 with weapons bay doors open.
2. Do not open the weapons bay doors with external stores installed on the pivot pylons above mach 0.90.
3. Due to buffeting, do not open the weapons bay doors with the speed brake extended.
4. Do not open the weapons bay doors inflight, with weapons bay tank(s) installed, until all fuel in the tanks has been used.

LANDING GEAR OPERATION LIMIT.

Do not exceed 1.20 "g" during landing gear extension or retraction. The maximum speed for landing gear extension, flight with the landing gear extended or for retraction is 295 KIAS.

RAM OR EMERGENCY MODE FLIGHT ENVELOPE.

Structurally, ram or emergency mode can be selected anywhere in the flight envelope; however, to insure equipment cooling and crew comfort when operating in a ram air mode (RAM or EMER), do not exceed an altitude of 25,000 feet. Airspeed should not be above 460 KIAS or below 260 KIAS.

CAUTION

During ram air operation, the IRRS, RHAWS *and ECM equipment must be turned off* immediately. Other nonessential electronic equipment should be turned off and forward equipment hot caution lamp monitored. Refer to "Caution Lamp Analysis", Section III.

TIRE LIMIT SPEED.

Maximum tire speed	205 *Knots ground speed.*
Emergency landing maximum tire speed	240 Knots ground speed.
Emergency takeoff *maximum tire speed* (one time only)	220 *Knots ground speed.*

Refer to figure 5-4 to determine the indicated airspeed (no wind) which is equivalent to the 205 knot ground speed tire limit. Figure 5-4 also provides instructions for applying the headwind or tailwind component correction to the indicated airspeed (no wind) obtained from the chart.

FLIGHT CONTROLS.

Do not exceed 295 KIAS or mach 0.62, whichever is less, with the flight control system switch in T.O. & LAND. With the flaps retracted, and wings aft of 26 degrees, do not place the control system switch to T.O. & LAND without first placing the flight control disconnect switch to OVRD.

WARNING

Attempting abrupt rolling maneuvers or bank angles in excess of 60 degrees with the flight control system in the takeoff and land configuration can result in loss of control of the aircraft.

TAXI SPEED.

Maximum taxi speeds:

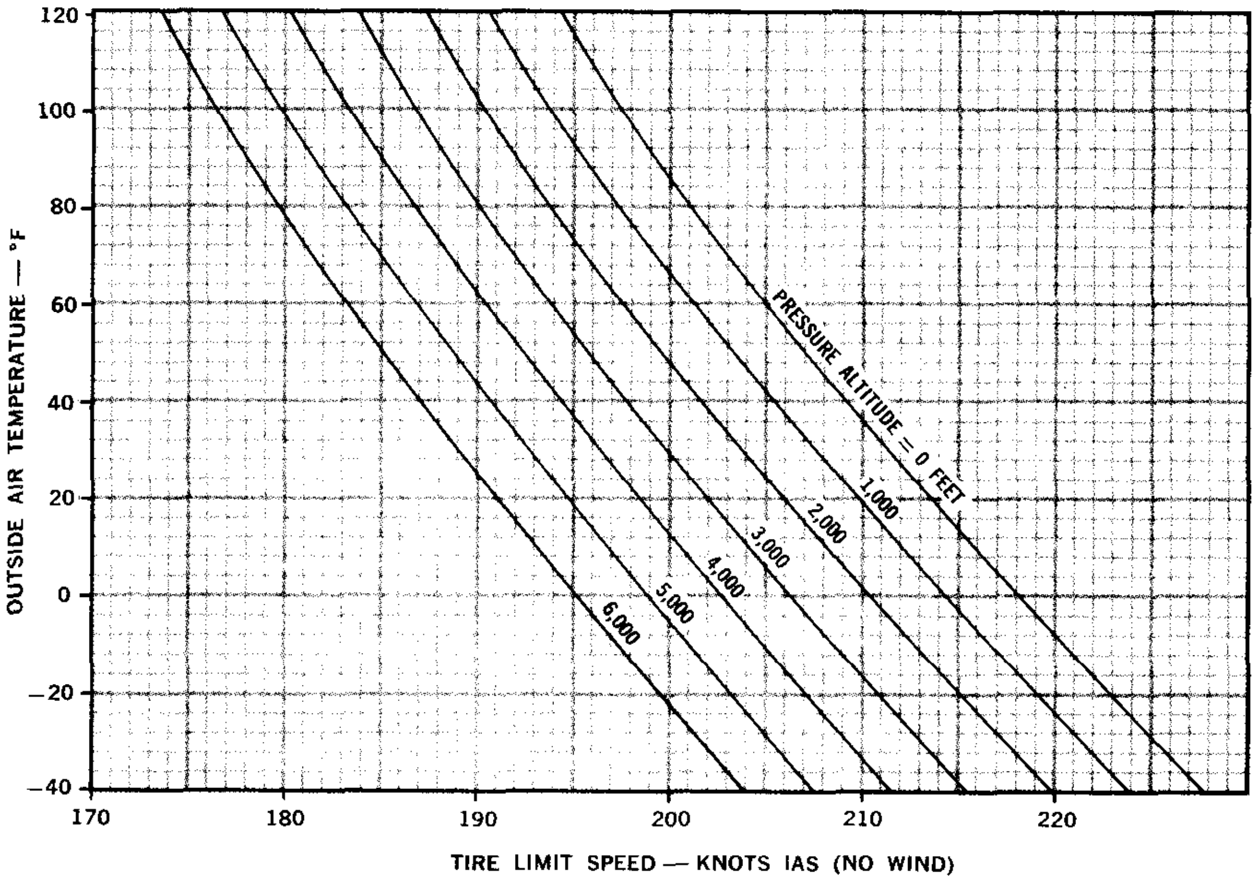
- 25 knots straight away
- 10 knots turning

Tire Limit Speed - MLG

DATA BASIS: ESTIMATED

TO BE USED FOR FB-111A WHEN EQUIPPED WITH:

- B.F. GOODRICH (47 x 18-18) 36 PLY RATING MAIN LANDING GEAR TIRES.
- B.F. GOODRICH (22 x 6.6-10 or 21 x 7.25-10) 20 PLY RATING NOSE LANDING GEAR TIRES.
- APPLICABLE TO ALL GROSS WEIGHTS
- FLAPS 25° TO FULL DOWN



NOTE:
1. THIS CHART IS TO DETERMINE THE AIRSPEED (NO WIND) WHICH IS EQUIVALENT TO THE 205 KNOT TIRE LIMIT GROUNDSPEED.
2. TO CORRECT FOR WIND CONDITION, DETERMINE THE NO WIND INDICATED AIRSPEED, THEN ADD THE HEADWIND COMPONENT OR SUBTRACT THE TAILWIND COMPONENT TO OBTAIN THE INDICATED AIRSPEED WHICH IS EQUIVALENT TO THE TIRE LIMIT GROUNDSPEED.

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Figure 5-4.

Maximum Arresting Hook Engaging Speed

DATA BASIS: ESTIMATED ABOVE 90,000 POUNDS
DATE: 4 JUNE 1971

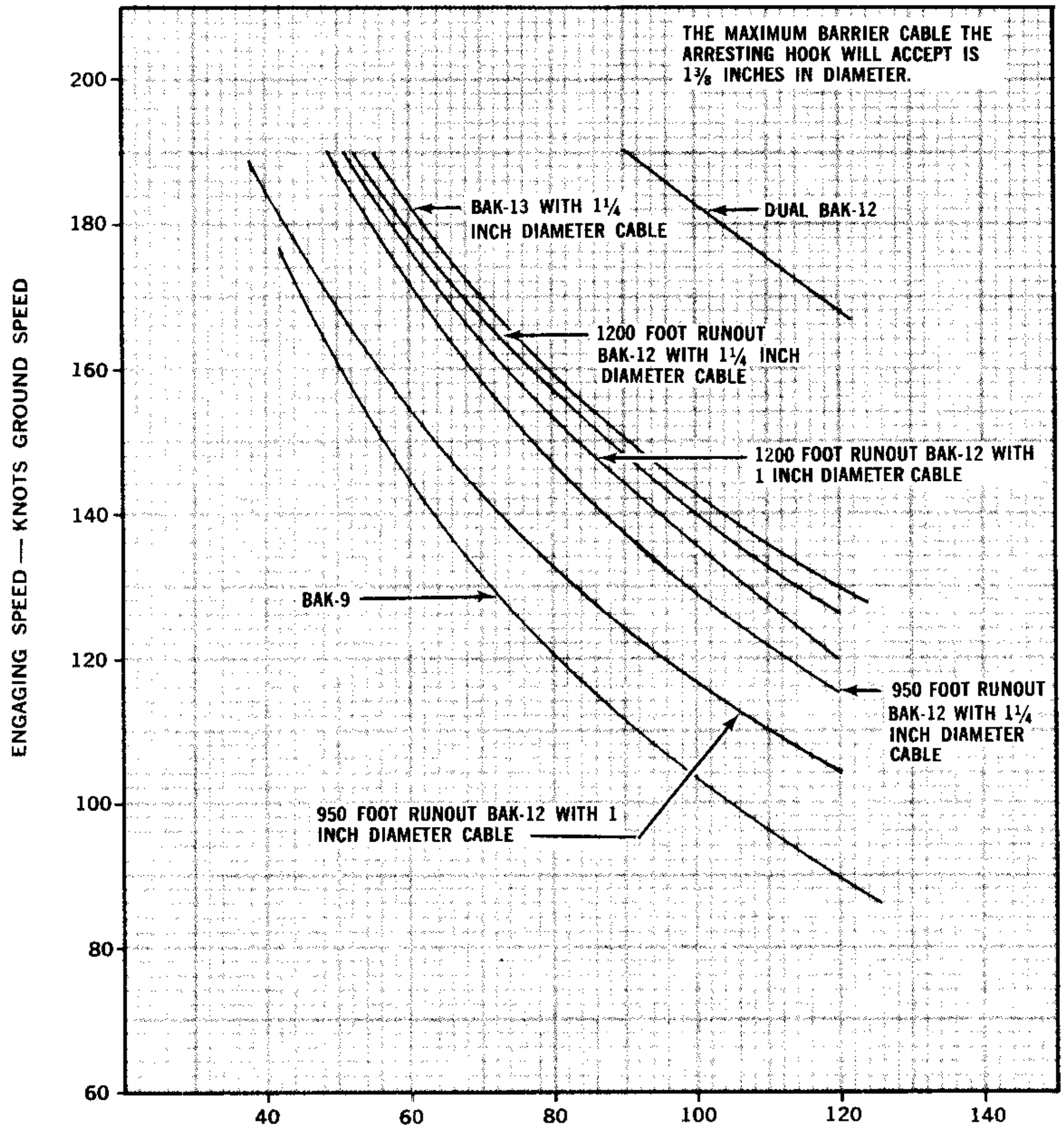
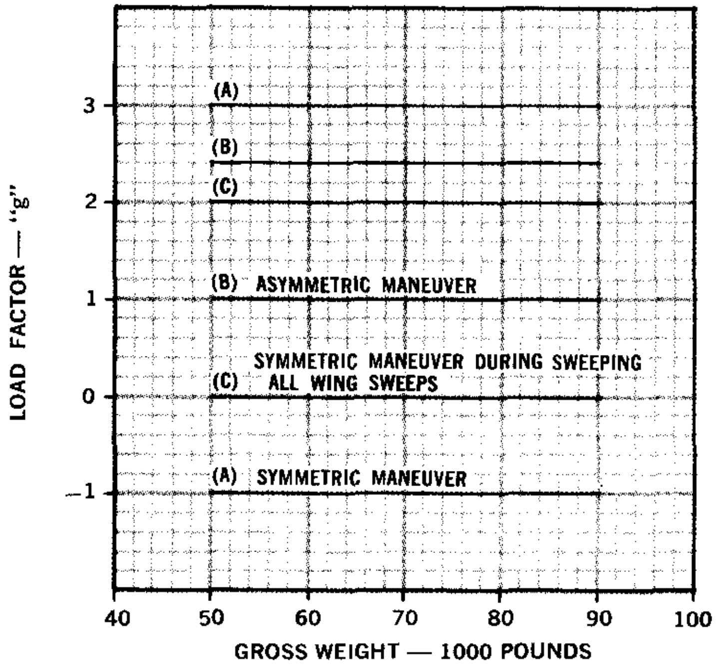


Figure 5-5.

Limit Maneuver Load Factors

DATA BASIS: ESTIMATED
DATE: 4 JUNE 1971

CONFIGURATION:
GEAR AND FLAPS UP
NO EXTERNAL STORES



CONFIGURATION:
GEAR AND FLAPS DOWN
WING SWEEPS 16-26 DEGREES
WITH OR WITHOUT EXTERNAL STORES

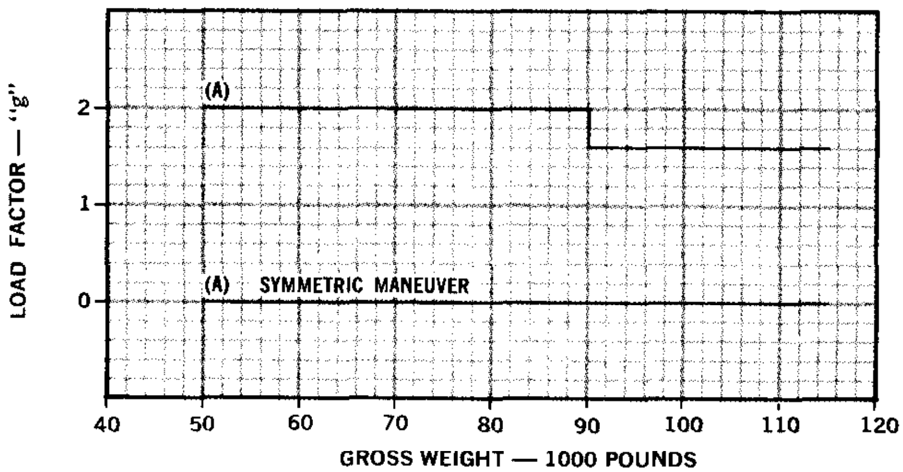


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Figure 5-6.

These limits are based on the possibility of overheating the tires during prolonged straight away taxiing and preventing excessive side loads on the landing gear when turning.

ARRESTING HOOK ENGAGING SPEED.

For maximum arresting hook engaging speed, refer to figure 5-5.

CAUTION

The maximum barrier cable the arresting hook will accept is 1⅜ inches in diameter.

MINIMUM FLYING SPEEDS.

The minimum flying speeds are defined by the maximum angle-of-attack limits presented in figure 5-7. For a discussion of minimum flying speeds, refer to Section VI.

SINGLE GENERATOR OPERATION – MINIMUM FLYING SPEED FOR (CSD) OIL COOLING.

Minimum airspeeds/altitudes for constant speed drive oil cooling for continuous single generator operation are as follows:

- 250 KIAS—20,000 feet and above.
- 200 KIAS—below 20,000 feet.

Note

Flight below minimum speeds is permitted for time not to exceed five minutes to accomplish required maneuvers.

MANEUVERABILITY LIMITATIONS.

LIMIT MANEUVER LOAD FACTORS.

Limit maneuver load factors as determined from structural considerations are presented in figure 5-6.

Angle-of-Attack and Rudder Deflection (Sideslip) Limitations

WING SWEEP (Degrees)	CONFIGURATION (With or without weapons)	ANGLE-OF-ATTACK	RUDDER SURFACE DEFLECTION LIMIT Applicable for all angles-of-attack.
16—26	Gear and slats/flaps down.	Below 0.40 mach: 14 degrees or stall warning activation whichever occurs first. Above 0.40 mach: • 10 degrees for flaps greater than 15 degrees. • 12 degrees for flaps at 15 degrees or less. • up to 14 degrees with slats only.	Yaw Damper On. 15 degrees. Yaw Damper Off. 12 degrees. Do not make abrupt rudder inputs.
16—49	Gear and slats/flaps up.	14 degrees or stall warning, whichever occurs first.	Yaw Damper On. • 6 degrees below mach 0.80. • 3 degrees above mach 0.80. Yaw Damper Off. No intentional sideslip.
50—72	Gear and slats/flaps up.	18 degrees or stall warning, whichever occurs first.	Yaw Damper On. • 6 degrees below mach 0.80. • 3 degrees above mach 0.80. Yaw Damper Off. No intentional sideslip.

Figure 5-7.

ROLL LIMITATIONS.

Maximum roll rates attainable in lateral maneuvers are a function of several factors such as flight conditions, store configuration, magnitude of command, abruptness of stick displacement, etc. Allowable stick displacements for flight beyond full normal stick limits are complicated and unwieldy to describe because of the many factors involved; however, the following operating procedures will serve as a guide to avoid excessive roll rates. The following roll limitations are based on 80 percent limit strength values for a clean aircraft. For other more restrictive limits with external stores refer to "Stores Limitations," this section.

Roll Limitations at All Wing Sweep Angles.

1. Do not exceed the force detent at any mach number at any altitude except under emergency conditions requiring more than normal lateral control.
2. At flight speeds for which full normal lateral stick is not allowed, do not exceed one-half normal lateral stick deflection and avoid abrupt lateral stick displacements.
3. Do not perform rolling maneuvers in excess of 360 degrees.
4. Do not perform rolling maneuvers at load factors less than 1 "g".
5. Prior to T.O. 1F-111-1020, do not rapidly reduce load factor while performing a rolling maneuver.

Roll Limitations at Wing Sweep Angles Where All Spoilers Are Operational.

1. Prior to T.O. 1F-111-1020, do not exceed ½ normal lateral stick deflection at speeds greater than 450 KIAS at any altitude.
2. With fuel in wings, do not exceed ½ normal lateral stick deflection at any mach number at any altitude.

Roll Limitations at Wing Sweep Angles Where Spoilers Are Not Operational.

At altitudes less than 25,000 feet, do not exceed ½ normal lateral stick deflection at speeds greater than 525 KIAS.

ANGLE-OF-ATTACK AND RUDDER DEFLECTION (SIDESLIP) LIMITATIONS.

The angle-of-attack and rudder deflection limitations presented in figure 5-7 must be observed. When in longitudinal maneuvering flight, large nose-up pitch rates can be developed if excessively large and/or abrupt aft stick movements are made. Under such conditions, it could be possible to overshoot the allowable angle-of-attack. As the angle-of-attack increases, the pitch rate of the aircraft should be moderated by forward stick movement to avoid exceeding the angle-of-attack limit. On aircraft prior to T.O. 1F-111-891 the rudder pedal shaker will activate when a combination of the values of pitch rate in degrees per second and wing angle-of-attack in degrees total 18 (±1). On aircraft modified by T.O. 1F-111-891, stall warning will activate at 14 degrees wing angle-of-attack for wing sweeps less than 50 degrees. For wing sweeps greater than 50 degrees, stall warning will be activated only above 14 degrees wing angle of attack when the combination of pitch rate in degrees per second and wing angle-of-attack in degrees total 18 (±1). Sideslip limitations are given in terms of rudder surface deflection limits since no direct method exists to determine sideslip angles. Sideslip limits are set to assure proper engine operation and should not be intentionally exceeded.

WARNING

- The rudder required to maintain coordinated flight increases as angle-of-attack increases. Attention should be given to coordinating rudder and lateral control when maneuvering at angles-of-attack above 10 degrees.
- Exceeding the rudder deflection limits to perform sideslips or rolling maneuvers can result in loss of control of the aircraft due to the roll and yaw characteristics of the aircraft and subsequent rapid build-up of angle-of-attack. When full rudder authority is available, care should be taken to assure that the rudder deflection limits are not exceeded.

FLIGHT WITH DAMPERS OFF.

Figure 5-8 presents the damper off operating limits. For a complete discussion, refer to "Flight with Dampers Off," Section VI. In the event of a flight control system malfunction necessitating turning the pitch, yaw, or roll damper off in flight, the aircraft speed should be reduced to that commensurate with figure 5-8 and the affected damper turned off. Continuing flight should be accomplished with a wing sweep of 26 degrees observing the airspeed limitations for this sweep presented in figure 5-8, and landing should be accomplished as soon as practical. In the event of damper failure with the gear down, flaps and slats extended, land as soon as practical. If retraction of flaps and slats is necessary, observe the limits in figure 5-8.

Damper Off Operating Limits

DO NOT EXCEED THE FOLLOWING AIRSPEEDS/ALTITUDES:		
PITCH DAMPER OFF		
Wing Sweep	*Altitude*	*Airspeed*
16 Degrees	No Restriction	Mach 0.40
26—45 Degrees	No Restriction	400 KIAS or mach 0.75 whichever is less
46—72.5 Degrees	Sea Level to 20,000 feet	Mach 0.70
	Above 20,000 feet	Wing sweep airspeed limits
ROLL OR YAW DAMPER OFF		
Wing Sweep	*Altitude*	*Airspeed*
16—45 Degrees	No Restriction	Wing sweep airspeed limits
46—72.5 Degrees	No Restriction	Mach 1.50

Figure 5-8.

WARNING

- During flight with pitch, yaw, or roll damper off, large and/or abrupt stick and/or rudder inputs should be avoided. Lateral maneuvers should be limited to 60 degree bank angle.

- For landing with pitch and/or yaw damper off, approach at 10 degree angle-of-attack (approach indexer setting). Approaches with the pitch damper off will require increased pilot attention to airspeed and angle-of-attack control.

CROSSWIND LANDINGS.

The maximum allowable crosswinds during landings with flaps extended and/or retracted are presented in figure 5-9. Crosswind landing with the flaps retracted will require a crabbed attitude at touchdown. Crosswind landings with flaps extended at wind speeds above approximately 75 percent of the maximum specified on the figure will also require a crabbed attitude at touchdown. Do not exceed a crab or yaw angle of 10 degrees at touchdown.

WARNING

With the flaps retracted do not attempt to align the aircraft with the runway prior to touchdown as sufficient roll control may not be available to hold the wings level.

Crosswind Takeoff and Landing Limits

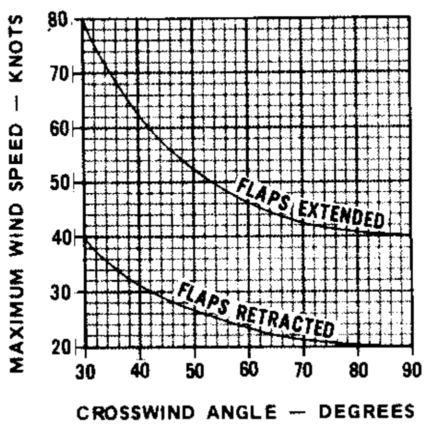

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Figure 5-9.

Refer to Section II, Crosswind Landings, for a discussion of the proper operating procedures.

PROHIBITED MANEUVERS.

The following maneuvers are prohibited:

- Spins
- Stalls
- Flight into heavy buffet.

CENTER-OF-GRAVITY LIMITATIONS.

AFT CENTER-OF-GRAVITY.

For a detailed discussion of aft center-of-gravity, refer to "Determination of the Aft Allowable Center-of-Gravity Position," Section VI. A simplified method for determining aft center-of-gravity limits is presented in figure 5-10 to provide a more readily available evaluation of the aircraft center-of-gravity in relation to the limitations. Figure 5-10 presents the aft center-of-gravity limits in terms of allowable horizontal stabilizer position and minimum fuel remaining. The maximum allowable horizontal stabilizer position is used for airspeeds below mach 2.0 and the minimum fuel remaining is used primarily for airspeeds above mach 2.0. These values are for stabilized flight with speed brake retracted and are "do not exceed" values.

Note

The maximum allowable horizontal stabilizer position is the maximum clockwise average position of the pointers (mid position between the pointers) on the control surface position indicator.

WARNING

When the maximum allowable horizontal stabilizer position is reached at speeds below mach 2.0 or minimum fuel remaining value is reached at speeds above mach 2.0, the aircraft is at the aft center-of-gravity limit for that specific wing sweep/airspeed/store loading condition. The aft center-of-gravity limit will be exceeded if flight is continued without changing wing sweep, airspeed and/or store loading to maintain the center-of-gravity within the allowable range specified in Section VI.

The minimum fuel values presented in figure 5-10 for flight at airspeeds below mach 2.0 are useful for mission planning purposes. However, it should be noted that they may be attained before reaching the specified maximum allowable horizontal stabilizer position limit. If the minimum fuel value is reached before attaining the maximum allowable horizontal stabilizer position, it is permissible to continue flight until reaching the maximum allowable horizontal stabilizer position limit even though the actual fuel remaining will be less than the minimum value presented in figure 5-10. For example, such a condition may occur when stores are loaded in the weapons bay. The minimum fuel values are based on the following considerations:

- An 8200 pound fuel differential (automatic fuel feed) has been maintained, and/or all the remaining fuel is in the forward tank.
- The weapons bay contains racks for carrying two B43's but weapons are not installed.
- Carriage of B43's and 600 gallon tanks only.
- Operating weight empty center-of-gravity with flaps and gear down and 26 degrees wing sweep is 46.4 percent MAC.

For wing sweeps greater than 45 degrees at airspeeds below mach 2.0, there is no aft center-of-gravity limit within the normal fuel and/or store loading capability of the aircraft. It should be noted from figure 5-10, however, that an increasing total fuel loading is required to maintain the center-of-gravity within the aft limits when wing sweep is reduced below 45 degrees.

Note

In view of the small differences in the maximum allowable horizontal stabilizer limits shown in figure 5-10 and the fact that the control surface position indicator cannot be easily read any closer than one degree, the following maximum allowable horizontal stabilizer positions are presented for rapid reference and will maintain an adequate safety margin under any conditions:

Gear and Flaps Down — 6.0 degrees up
Gear and Flaps Up
  Less than 0.75 mach — 1.0 degree up.
  Greater than 0.75 mach — 2.0 degrees up.

Speed brake extension causes a nose-up pitching moment which will require a down horizontal stabilizer correction to arrest; therefore, for flight with the speed brake extended, the maximum allowable horizontal stabilizer position shown in figure 5-10 is not applicable and may be temporarily exceeded. It is recom-

Center-Of-Gravity Limits (Based on Stabilizer Position|Fuel Remaining)

Data Basis: Estimated
Date: 1 June 1973

Fuel Grade: JP-4
Engines: TF30-P-7

THE STABILIZER POSITION ALLOWABLE IS THE AVERAGE POSITION OF THE POINTERS ON THE CONTROL SURFACE POSITION INDICATOR. IF THE AVERAGE STABILIZER POSITION WHILE IN 1.0 "g" FLIGHT AT 10 DEGREES ANGLE-OF-ATTACK WITH THE FLAPS AND GEAR EXTENDED IS NOT WITHIN THE REQUIRED RANGE, OR AT 8 DEGREES OR LESS ANGLE-OF-ATTACK WITH THE FLAPS AND GEAR RETRACTED EXCEEDS THE VALUE IN A CLOCKWISE DIRECTION, THE AIRCRAFT CENTER-OF-GRAVITY HAS EXCEEDED THE LIMITS FOR THAT COMBINATION OF WING SWEEP AND PYLON LOADING.

CONSIDERATIONS:

Minimum fuel remaining is based on:

a. Normal fuel usage.
b. The weapons bay does not contain racks, weapons, or tanks.
c. Carriage of B43's and 600 gallon tanks only.
d. Operating weight empty center-of-gravity with gear and flaps down and 26 degrees wing sweep is 46.2 percent MAC.

		GEAR AND FLAPS DOWN		GEAR AND FLAPS UP					
	WING SWEEP	16 DEGREES	26 DEGREES	16 DEGREES		26 DEGREES		35 DEGREES	AFT WING SWEEP
	AIRSPEED	*Flap Limit Speed or Less*	*Flap Limit Speed or Less*	*Mach 0.60 or Less*	*Mach Greater Than 0.60*	*Mach 0.75 or Less*	*Mach Greater Than 0.75*	To Limit Airspeed	Above Mach 2.0
	FLAP DEFLECTION	34 Degrees Aux. Extended	34 Degrees						
	STABILIZER POSITION	4 to 12 Deg. (6) T.E. Up (5)	4 to 12 Deg. T.E. Up (6)	0 Deg. T.E. Up Max CW	0.5 Deg. T.E. Up Max CW	0.5 Deg. T.E. Up Max CW	2.0 Deg. T.E. Up Max CW	0 Deg. T.E. Up Max CW	Minimum Fuel-Pounds
CONFIGURATION	EXTERNAL STORES	Fuel-Pounds	Fuel-Pounds	Minimum Fuel-Pounds	Minimum Fuel-Pounds	Minimum Fuel-Pounds	Minimum Fuel-Pounds	Minimum Fuel-Pounds	
BASIC AIRCRAFT	0	Min 6,500 (7) Max (2)	Min 0 Max 3,900 (8)	1,200	7,800	0	1,300	0 (3)	3,400
STORES ON PIVOTING PYLONS ONLY ★	2 Weapons	Min 5,800 (7) Max (2)	Min 0 Max 2,700 (8)	800	8,700	0	1,700	0 (3)	3,200
	4 Weapons	Min 5,700 (7) Max (2)	Min 0 Max 2,500 (8)	0	13,000	0	2,500	0 (3)	5,800
	2 Tanks	Min 8,000 (7) Max (2)	Min 0 Max 3,700 (8)	3,800	(1)	2,000	3,900	400 (4)	
	4 Tanks	Min 8,200 (7) Max (2)	Min 0 Max 3,800 (8)	7,100	(1)	4,000	5,700	3,400 (4)	
	2 Weapons & 2 Tanks	Min 6,700 (7) Max (2)	Min 0 Max 2,800 (8)	3,100	(1)	1,300	3,700	600 (4)	
STORES ON PIVOTING AND FIXED PYLONS ★	2 Weapons & 4 Tanks	Min 7,600 (7) Max (2)	Min 0 Max 3,400 (8)	4,600	(1)	3,700	5,600		
	4 Tanks	Min 8,200 (7) Max (2)	Min 0 Max 4,600 (8)	5,500	(1)	4,500	7,100		
	6 Tanks	Min 13,400 (7) Max (2)	Min 0 Max 4,400 (8)	6,700	(1)	5,700	7,400		

NOTES:

Accuracy of the elevator position indicator can be checked by depressing the takeoff trim button until lamp lights. Pointer should indicate 3.8 degrees trailing edge up.

(1) Using the minimum fuel remaining considerations above, there is no fuel loading at which the center-of-gravity does not exceed the aft limit.

(2) The center-of-gravity does not exceed the forward limit for any normal fuel loading.

(3) For wing sweeps aft of 35 degrees, there is no aft center-of-gravity limit within the normal fuel and store loading capability.

(4) For wing sweep aft of 45 degrees, there is no aft center-of-gravity limit within the normal fuel and store loading capability.

★ (5) If the AUX flap is retracted, the stabilizer position range is 6 to 15 degrees.

(6) The stabilizer position ranges are applicable to flap deflections from 25 to 34 degrees.

(7) Fuel levels less than these values require the wings to be swept aft to remain within the aft cg limits.

(8) Fuel levels greater than these values require the wings to be swept forward to remain within the forward cg limits.

Figure 5-10.

mended that the speed brake be periodically retracted and the maximum allowable horizontal stabilizer position limit checked if prolonged flight is conducted with the speed brake extended. If speeds in the range of mach 2.0 to 2.2 are to be flown, it is recommended that the minimum fuel remaining values for flight at mach 2.2 be used.

FORWARD CENTER OF GRAVITY.

The forward center-of-gravity limits for takeoff and landing with flaps are as follows:

- 26 degree wing sweep:
  Full flaps—41.0 percent MAC.
  25 degrees flaps—38.0 percent MAC.
- 16 degree wing sweep:
  Full flaps—22.0 percent MAC.
  25 degrees flaps—15.0 percent MAC.

The forward center-of-gravity limits for landing with flaps as a function of wing sweep, in terms of maximum allowable trailing edge up horizontal stabilizer position, are as follows:

- 26 degree wing sweep—12.0 degrees trailing edge up.
- 16 degree wing sweep—15.0 degrees trailing edge up without aux flap. (12 degrees with aux flap)

The elevator position limits are applicable only at 10 degrees angle-of-attack. Once the landing configuration and approach attitude (10 degrees angle-of-attack) have been established, monitor the control surface position indicator to determine if the aircraft is within the forward center-of-gravity limit. For certain combinations of fuel remaining and bay and/or external loadings, it may be necessary to land with the wings positioned forward of 26 degrees in order to attain a center-of-gravity within the forward center-of-gravity limits. If it is necessary to sweep the wings forward of 26 degrees for landing, monitor elevator position to assure that the aft center-of-gravity limits are not exceeded. The above limits are based on maintaining sufficient longitudinal control to achieve at least 18 degrees angle-of-attack with flaps and slats extended and full back stick.

Note

The maximum allowable horizontal stabilizer position specified above is the maximum trailing edge up average position of the pointers (mid position between the pointers) on the control surface position indicator. In view of the small differences in the horizontal stabilizer limit shown, and the fact that the control surface position indicator cannot be easily read any closer than one degree, a value of 9 degrees trailing edge up may be used for rapid reference and will maintain an adequate safety margin under any conditions.

CREW MODULE CENTER-OF-GRAVITY LIMIT.

WARNING

The crew module should not be considered flyable without its full crew and complement of survival equipment, or the equivalent ballast to maintain center-of-gravity. In the event that combined crew weight, including personal equipment, exceeds 430 pounds, or the weight differential between the two occupants exceeds 65 pounds, low altitude safe escape will be compromised and landing impact acceleration will increase. To assure stability of the crew module in event of ejection, it must be loaded in accordance with T.O. 1-1B-40.

GROSS WEIGHT—CENTER OF GRAVITY LIMITATIONS FOR TAXI AND GROUND OPERATION.

Loadings which result in an aft center-of-gravity in excess of 60 percent MAC can cause the aircraft to tip back when brakes are released with AB power. At light gross weights, forward wing sweep angles will minimize nose wheel steering difficulties.

GROSS WEIGHT LIMITATIONS.

Taxi, takeoff and landing operations at weights above 90,000 pounds shall be confined to well prepared runways until completion of structural certification tests.

MAXIMUM GROSS WEIGHT.

Maximum gross weight limits are as follows:

- Taxi and ground operation—122,900 pounds.
- Takeoff and inflight—114,300 pounds.
- Landing—109,000 pounds.

AIRCRAFT SINK RATE AT TOUCHDOWN.

The allowable sink rate at touchdown shall not exceed 600 feet per minute at landing gross weights up to the maximum allowable with any authorized weapon and/or stores loading, except if any usable fuel remains in the external tanks, the allowable sink rate shall not exceed 360 feet per minute.

BRAKE LIMITATIONS.

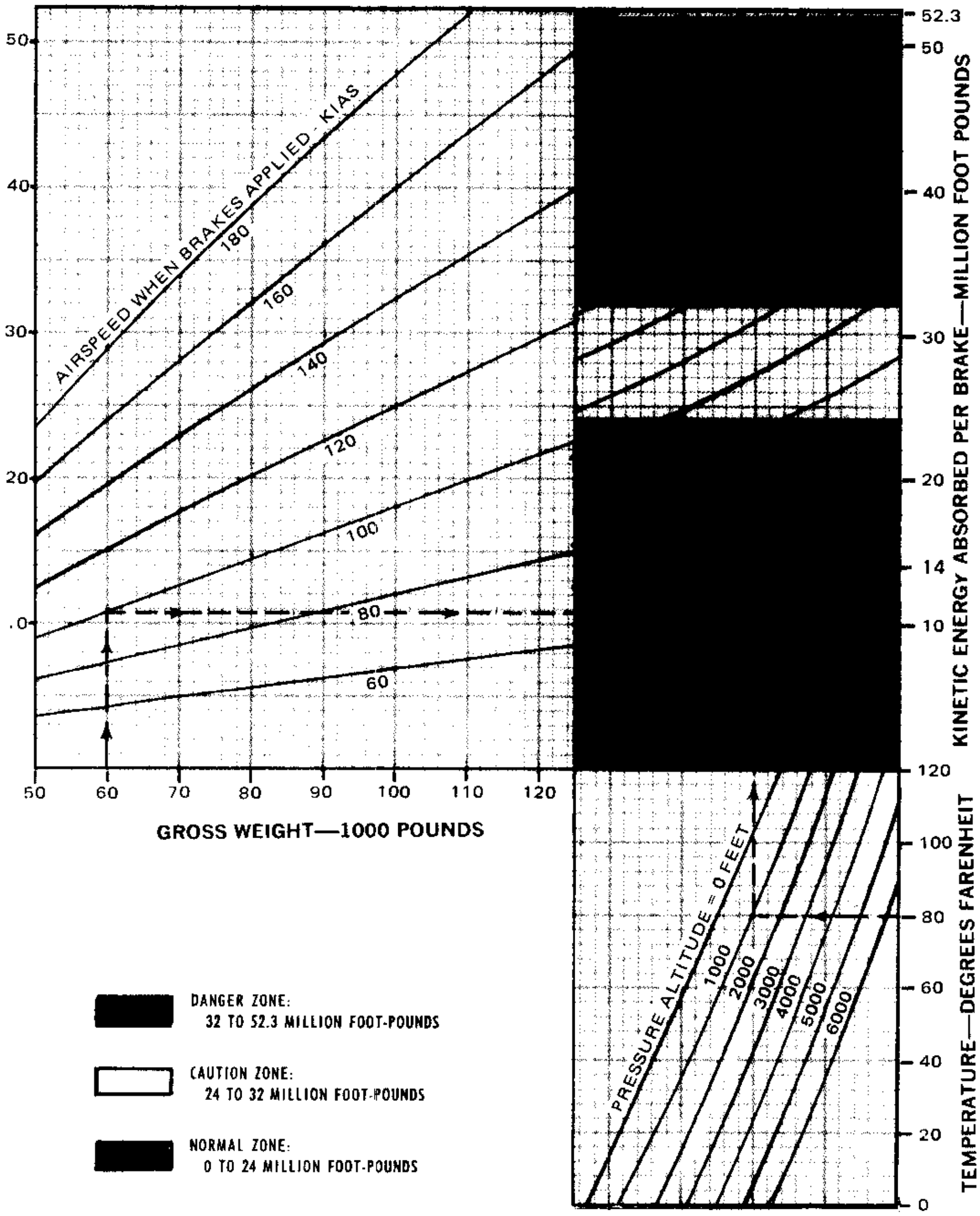
BRAKE APPLICATION SPEED LIMIT.

Brake energy limits with slats, flaps and spoilers extended are presented in figure 5-11. The example lines explain how to determine the amount of energy absorbed by the brakes during a stop.

Brake Energy Limits

DATA BASIS: ESTIMATED
DATE: 4 JUNE 1971

CONFIGURATION:
SLATS-FLAPS-SPOILERS EXTENDED



FOR ABORTED TAKEOFF DO NOT EXCEED 47.5 MILLION FOOT POUNDS

NOTE:
SUBTRACT 50 PERCENT OF THE HEADWIND COMPONENT, MEASURED BY THE TOWER, FROM THE IAS. A TAILWIND COMPONENT MUST BE ADDED TO THE IAS.

THE FOLLOWING INFORMATION EXPLAINS ACTION TO BE TAKEN WHEN A STOP IN THE DANGER, CAUTION, OR NORMAL ZONES IS PERFORMED:

DANGER ZONE

1. Use moderate braking below 25 knots until taxi speed of 5—10 knots is obtained. Release brakes, if possible, and maintain forward motion. Request fire fighting equipment.

CAUTION

Applying maximum brake pressure below 25 knots may cause brake rotors and stators to fuse together.

2. Proceed to the nearest parking area clear of other airplanes and personnel without stopping and as quickly as possible. Do not set parking brakes or shut down engines.
3. Hydraulic fluid fire is imminent. Approach main landing gear from front or rear for fire fighting purposes only.
4. Extinguishing agents shall be applied as a fog or foam on the tires and directly to the brakes. Do not spray liquid directly on the wheels.
5. If possible, delay engine shutdown until arrival of fire fighting equipment. If immediate evacuation is required, shut down engine as required. In either case, after engine shutdown, evacuate aircraft immediately. Leave immediate vicinity keeping forward of the aircraft.

CAUTION ZONE

1. Request fire fighting equipment. Do not set parking brakes or shut down engines until fire fighting equipment arrives. Hydraulic fire is possible.
2. The area in the vicinity of the main landing gear within 50 ft. of any brake should be regarded as unsafe during the first one hour and 15 minutes after the stop, unless the thermal release plugs have blown allowing the tires to be deflated.
3. Do not attempt takeoff until the brake housings and tires are cool to the bare hand to prevent possible tire failure during takeoff or in flight.

NORMAL ZONE

1. Parking brakes may be set.
2. If stop does not exceed 18 million foot pounds per brake, subsequent takeoff may be performed immediately. However, brake application is restricted to speeds and gross weights in the CAUTION ZONE or below in the event a subsequent takeoff is aborted.
3. Unrestricted subsequent takeoff may be performed only after brake housings and tires are cool to the bare hand.
4. If stop exceeds 18 million foot pounds per brake, subsequent takeoff may be performed only after brake housing and tires are cool to the bare hand.

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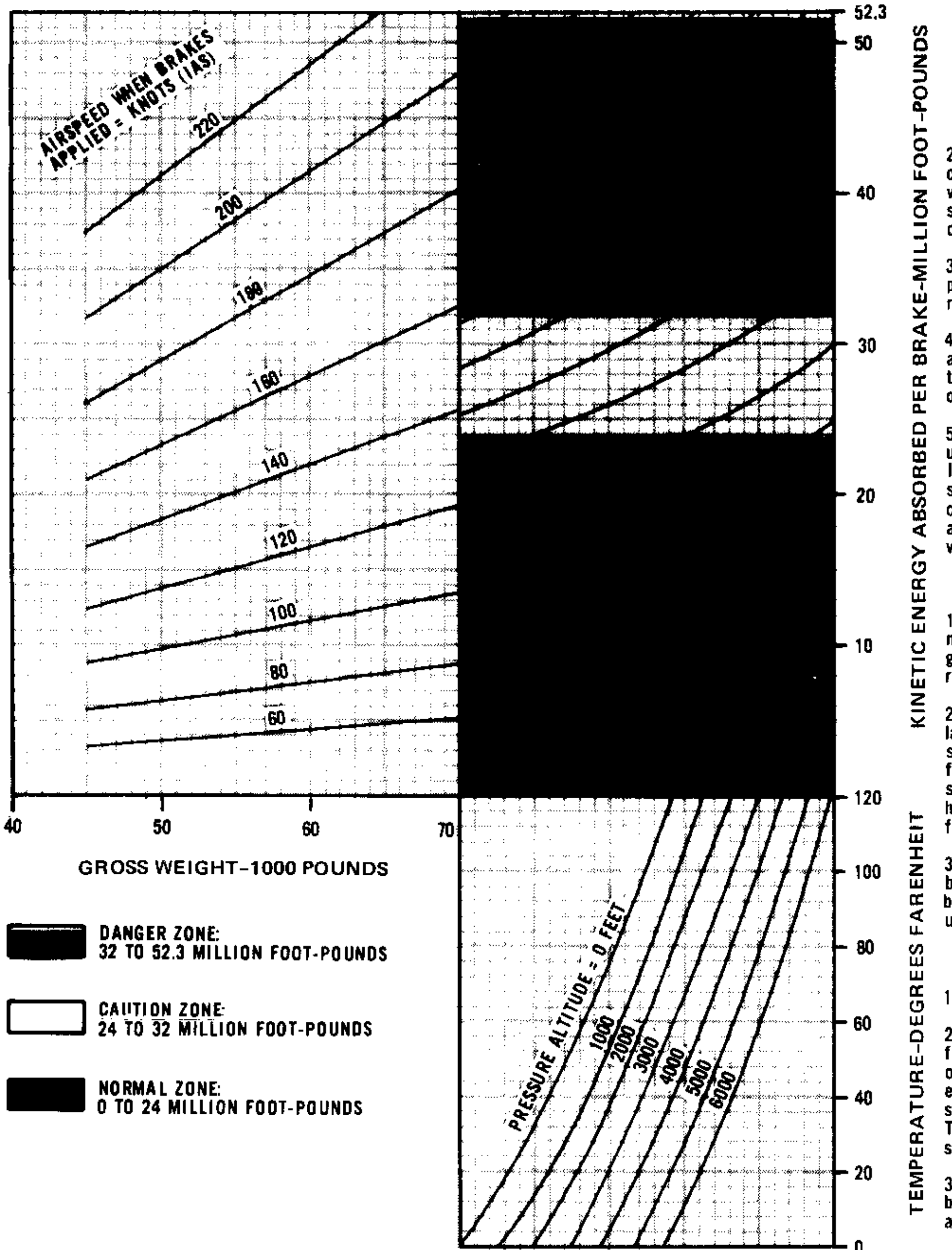
Figure 5-11. (Sheet 1)

Brake Energy Limits

THE FOLLOWING INFORMATION EXPLAINS ACTION TO BE TAKEN WHEN A STOP IN THE DANGER, CAUTION, OR NORMAL ZONES IS PERFORMED:

DATA BASIS: ESTIMATED
DATE: 29 DECEMBER 1972

EMERGENCY LANDING WITH
SLATS-FLAPS-SPOILERS RETRACTED



DANGER ZONE:
32 TO 52.3 MILLION FOOT-POUNDS

CAUTION ZONE:
24 TO 32 MILLION FOOT-POUNDS

NORMAL ZONE:
0 TO 24 MILLION FOOT-POUNDS

NOTE:
SUBTRACT 50 PERCENT OF THE HEADWIND COMPONENT, MEASURED BY THE TOWER, FROM THE IAS. A TAILWIND COMPONENT MUST BE ADDED TO THE IAS.

DANGER ZONE

1. Use moderate braking below 25 knots until taxi speed of 5–10 knots is obtained. Release brakes, if possible, and maintain forward motion. Request fire fighting equipment.

CAUTION

Applying maximum brake pressure below 25 knots may cause brake rotors and stators to fuse together.

2. Proceed to the nearest parking area clear of other airplanes and personnel without stopping and as quickly as possible. Do not set parking brakes or shut down engines.

3. Hydraulic fluid fire is imminent. Approach main landing gear from front or rear for fire fighting purposes only.

4. Extinguishing agents shall be applied as a fog or foam on the tires and directly to the brakes. Do not spray liquid directly on the wheels.

5. If possible, delay engine shutdown until arrival of fire fighting equipment. If immediate evacuation is required, shut down engine as required. In either case, after engine shutdown, evacuate aircraft immediately. Leave immediate vicinity, keeping forward of the aircraft.

CAUTION ZONE

1. Request fire fighting equipment. Do not set parking brakes or shut down engines until fire fighting equipment arrives. Hydraulic fire is possible.

2. The area in the vicinity of the main landing gear within 50 ft. of any brake should be regarded as unsafe during the first one hour and 15 minutes after the stop, unless the thermal release plugs have blown allowing the tires to be deflated.

3. Do not attempt takeoff until the brake housings and tires are cool to the bare hand to prevent possible tire failure during takeoff or in flight.

NORMAL ZONE

1. Parking brakes may be set.

2. If stop does not exceed 18 million foot pounds per brake, subsequent takeoff may be performed immediately. However, brake application is restricted to speeds and gross weights in the CAUTION ZONE or below in the event a subsequent takeoff is aborted.

3. Unrestricted subsequent takeoff may be performed only after brake housings and tires are cool to the bare hand.

4. If stop exceeds 18 million foot pounds per brake, subsequent takeoff may be perfomed only after brake housing and tires are cool to the bare hand.

F0000000-F049C

Figure 5-11. (Sheet 2)

Note

Subtract 50 percent of the headwind component, measured by the tower, from the IAS. A tailwind component must be added to the IAS.

Example: Full Stop Landing

Given: Gross weight = 60,000 pounds.
Airspeed when brakes applied = 95 knots IAS.
Tower reported wind velocity = 5 knot tailwind.
Pressure altitude = 1000 feet.
Outside air temperature = 80 degrees F.

Find: Brake Energy Absorbed.

Solution:

Following example lines on figure 5-11, the brake energy absorbed is 14.0 million foot-pounds per brake.

WARNING

If maximum braking capacity is utilized (danger zone), wheel blowout plugs will relieve tire pressure within 15 minutes after the stop. Provisions should be made to cope with possible wheel fires which may start shortly after blowout plug release.

MISCELLANEOUS OPERATIONAL LIMITATIONS.

SPEED BRAKE LIMIT.

1. Speed brake operation is limited to 600 KIAS or mach 2.0, whichever is less.
2. No evaluation has been made with speed brakes and weapons bay doors open, therefore, do not attempt simultaneous operation.

CANOPY HATCH OPERATING SPEED.

Do not open canopy hatch or taxi with the canopy hatch open when relative wind is in excess of 60 knots.

TERRAIN FOLLOWING RADAR OPERATION.

Terrain following radar operation is permitted and is limited to the following:

1. Strict observance of minimum TF operation airspeeds (Appendix I).
2. Wing sweep angles of 26 to 72 degrees.
3. Blind letdown to an initial clearance of 1000 feet. (After level-off at 1000 feet, the desired operating clearance can be selected.)
4. A minimum altitude of 500 feet when in manual mode using the E scope only.
5. A maximum of 0.85 mach in weather mode (500 feet set clearance) and a maximum of 0.95 mach in all other set clearances.
6. Bank angles of 30 degrees or less in either manual or auto TF.
7. Set clearances for each route segment, during night or IFR conditions, that will be at least 200 feet higher than any obstacle in the flight path that may not provide a reliable radar return.

Note

The 200 feet clearance should not normally be used over mountainous terrain during night or IFR conditions.

8. Operation with external stores as stated under "Stores Limitations," this section.

In addition to the above limitations, do not attempt or continue auto or manual TF operations if any of the following flight control system malfunctions exist:

9. Any known pitch trim malfunction or any pitch axis caution lamp that will not reset.

Note

For a pitch channel or pitch damper lamp that will reset, verify that the lamp does not come on during an intentionally induced fly-up maneuver before continuing TF operation.

10. Yaw channel caution lamp will not reset.
11. TF fly-up off caution lamp on.
12. Reference not engaged caution lamp on, after auto TF is engaged. (Prior to T.O. 1F-111(B)A-593)
13. ATF not engaged caution lamp lighted, after auto TF is engaged. (After T.O. 1F-111(B)A-593)

CAUTION

These limits are peculiar to TF operation. Other emergency procedures regarding caution lamps must be followed at all times.

Do not use the autopilot in the mach or altitude hold mode during operation in the transonic flight region between 0.90 and 1.10 mach.

AILA OPERATING LIMITS.

Prior to T.O. 1F-111(B)A-651, AILA is limited to daylight VFR conditions.

STORES LIMITATIONS.

The authorized stores loadings are identified in figure 5-13. The table contained in figure 5-13 directs attention to the appropriate chart for carriage or selective jettison limits for the stores authorized. Other more restrictive limits which apply to the aircraft must be observed and the miscellaneous stores limits must be used in conjunction with figure 5-13.

PYLON LIMITS.

Fixed Pylons.

- Maximum allowable wing sweep with fixed pylons installed is 26 degrees.

Fuel Pylon Limits.

- On aircraft 7 ➧ 11, flight with fixed and pivot fuel pylons is prohibited until T.O. 1F-111(B)A-589 has been complied with.

Weapon Carriage Pylon Limits.

- When only empty pivoting weapon pylons and racks are attached, the clean aircraft airspeed and maneuver load factor limits apply.
- Flight with fixed weapon pylons is not authorized.
- On aircraft 7 ➧ 39, flight with pylons at stations 3 and 6 is prohibited until T.O. 1F-111-876 has been complied with.

Weapon Pylon Release Limits.

Weapon pylons can be jettisoned in straight and level flight within the following limits:

Altitude—Up to 20,000 feet.
Speed—Up to 0.55 mach.
Gear and flaps—Up.
Speedbrake—Retracted.
Wing Sweep—26 degrees.

Pylons can only be jettisoned in symmetrical pairs.

CAUTION

When jettisoning the inboard pylons intercollision of the pylons may result in damage to the aircraft.

Rack Limits.

- MAU-12 C/A, MAU-140/A and BRU-3A/A are the only authorized racks.
- All weapon bay installations will use either MAU-12 C/A racks with bomb lug chocks installed or MAU-140/A racks for SRAM loadings.

Internal and/or External Combined Loadings.

- Any of the weapons bay loadings can be combined with any external nuclear loading or external tank loading listed in the authorized loading table, Figure 5-13.
- One or two weapons bay fuel tanks are the only internal loadings that can be combined with the conventional weapon loadings.
- An intermix of conventional weapons with the nuclear weapon loadings or external fuel tanks is not allowed.

Carriage Limits.

Symmetric Loadings.

Roll rate limits:

Weapons bay loadings	—Clean aircraft roll limit.
Nuclear weapons only	—Clean aircraft roll limit.
Cluster loadings	—70°/second.
External fuel tanks	—60°/second.

The roll rate limit varies for different stores loadings. Since roll rate must be estimated by the pilot, a recommended means of limiting roll rate is to limit lateral stick displacement to one-half that attainable at the force detent.

WARNING

Failure to observe the maximum allowable roll rates during rolling maneuvers may result in loss of the stores. With heavy store loadings, excessive roll rate may cause structural damage to or failure of the weapons racks, pylons or wing-pylon attachment.

Asymmetric Loadings.

- Flight limits are based on symmetric loads and normal (automatic) fuel usage. The carriage envelopes are applicable to the defined takeoff loadings and each subsequent in-flight down-loading. For most of the loadings very little or no additional carriage

envelope restriction is required to handle typical asymmetric loadings which may occur.

CAUTION

The use of release modes other than those authorized, especially for weapon cluster loadings, can result in extreme lateral loading asymmetry or critical hung-store configurations. Damage to, or failure of, racks pylons or wing-pylon attachments may occur.

- If fuel will not transfer from outboard tank(s) and inboard tank fuel is needed, reduce speed to 0.75 mach or 300 KIAS, whichever is less, and proceed with manual fuel transfer. If mission requires operation above this speed, jettison outboard tank(s) in accordance with "Fuel Tank Jettison Procedures", Section IV except, under these conditions, tank(s) must be empty or have more than 1800 pounds of fuel remaining.

WARNING

Do not jettison tank(s) with below 1800 pounds of fuel remaining unless empty. To do so, may result in tank(s) colliding with aircraft.

- Asymmetric fuel loading of 3900 pounds or less is allowable for a symmetric pair of tanks provided there are no abrupt lateral stick inputs.

WARNING

When an asymmetric loading condition exists, lateral trim requirements will increase with load factor; that is, the aircraft will tend to roll more into the heavy wing when positive load factors are applied. When lateral control requirements become large during maneuvers, it may be necessary to reduce load factor to maintain lateral control.

- If external tank fuel loading asymmetry exceeds 3900 pounds, land as soon as practicable observing the following limits:
  1. Observe nominal one "g" flight. Control inputs must be smooth—not abrupt.
  2. Limit bank angle to 30 degrees or less.
- Asymmetric loadings of one store asymmetry are allowed for nuclear weapons loadings.
- Asymmetric weapon loading of a four store cluster load on a single station is allowable provided there are no abrupt lateral stick inputs.
- Any asymmetric weapon loading that includes a six store cluster or a dual station asymmetry (single weapons or four store cluster loadings) on the same wing, observe the following limits:
  1. No abrupt lateral stick inputs.
  2. Limit bank angles to 30 degrees or less.

Release Limits.

- Authorized normal release modes for conventional weapons:
  1. Single stores per pylon—STEP SINGLE.
  2. Four store clusters on pylons 4 and 5 only.—STEP SINGLE OR PAIR, TRAIN SINGLES OR PAIRS.
  3. Six store clusters—TRAIN SINGLES OR TRAIN PAIRS.

Note

For train releases:

- Symmetric pairs of pylons must be selected.
- Weapon release button must be depressed long enough to release all stores on the selected stations.

For step single releases from four weapon clusters:

- Symmetric pairs of pylons must be selected. (Weapons will then be stepped alternately from one wing station then the opposite wing station, i.e. never have asymmetry of more than one store.)

- Release of stores from the weapons bay is limited to mach 0.85 with stores remaining on the pylons.

CAUTION

If other than normal (auto) fuel system operation is used, check that the center-of-gravity will be forward of the aft limit after release from the weapons bay.

- Pylon stores must be released outboard to inboard. Refer to Section IV for Fuel Tank Jettison Procedures and to Section III for Emergency Jettison Procedures.
- Nuclear weapons will not be released from external stations at wing sweeps of 60 degrees or greater. (55 degrees for B-43 at airspeeds greater than mach 1.2).

• The following longitudinal and lateral maneuver limitations apply to weapon release/launch under any of the following modes of flight: Pilot manual control, auto TF, or autopilot.

1. Normal "g" loading (positive 1 "g" or greater) must be held constant or increased for three seconds after bomb release.
2. Rolling maneuvers within one second after the last bomb is released in a particular drop are prohibited.
3. Maintain straight and level flight, or flight within the limits specified in figure 5-12 for a period of 5 seconds before to 5 seconds after SRAM launch. This is to assure proper missile battery fill and to prevent the possibility of aircraft/missile collision.

Hung Store Jettison.

Non-nuclear loadings other than takeoff loadings, i.e., hung bombs or partial down loads, should be retained if at all possible. If emergency jettison is deemed necessary, refer to the associated "Release and Jettison Limits" chart, this section.

WARNING

- Emergency jettison at wing sweep angles other than 26° may result in damage to the aircraft.
- Emergency jettison of hung bombs, partial down loadings, or any loadings other than the authorized takeoff loadings may result in damage to the aircraft.

TFR Limits When Carrying Stores.

CAUTION

TFR operation with external stores is not permitted at gross weights where carriage limits do not permit a 2.8 "g" symmetric maneuver load factor.

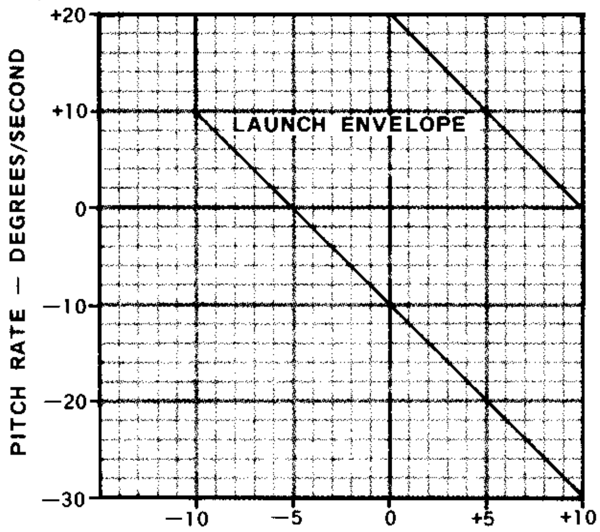
Note

During auto TF operation with external stores, the asymmetric maneuver load factor limit shown in this section may be inadvertently exceeded. Should this occur, an entry in the aircraft Form 781 will be made to assure appropriate inspection of the pylons and stores. A Form 781 entry is not required if the asymmetric maneuver load factor limits provided are exceeded during auto TF operation without external stores (clean aircraft configuration).

SRAM Launch Limits

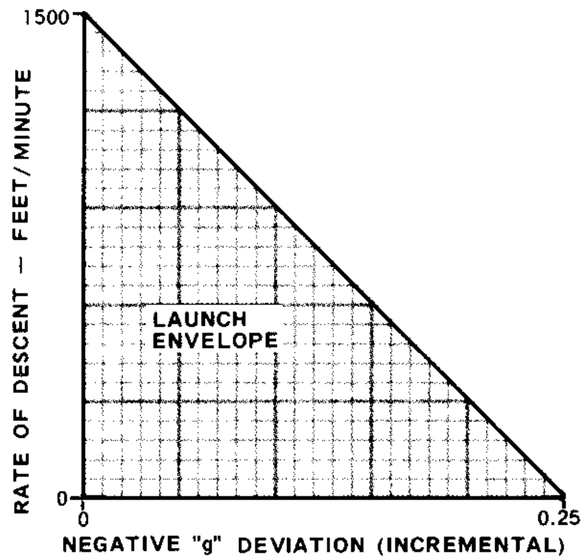
1. MINUS 5 SECONDS TO IMMEDIATELY PRIOR TO LAUNCH. (TO INSURE MISSILE BATTERY FILL)
   - PITCH = ±60 DEGREES
   - ROLL = 60 DEGREE BANK
   - "g" = 0 TO +3.0 "g"

2. IMMEDIATELY PRIOR TO LAUNCH (COMPUTER INHIBIT)



- ROLL = 10 DEGREE BANK
- SIDE SLIP = 0.25 "g"
- "g" = +0.5 TO +3.0 "g"
- VERTICAL VELOCITY = +3,000 TO -1,320 FEET/MINUTE

3. LAUNCH TO PLUS 5 SECONDS (TO PREVENT MISSILE/AIRCRAFT CONTACT)



- STEADY RATE OF DESCENT
- STEADY "g"

F0000000-F101

Figure 5-12.

Authorized Stores Loading Table

STORES	1	2	3	4	R	L	5	6	7	8	CARRIAGE ENVELOPE	RELEASE ENVELOPE	NOTES
	STATIONS										FIGURE NUMBER		
Tanks				T	#	#	T				Fig. 5-15	Fig. 5-16	1
			T	T	#	#	T	T			Fig. 5-14, Sht 1	Fig. 5-16	1
			T	*	#	#	*	T			Fig. 5-15	Fig. 5-16	1
		T	T	*	#	#	*	T	T		Fig. 5-14, Sht 2	Fig. 5-16	1
		T	T	T	#	#	T	T	T		Fig. 5-14, Sht 2	Fig. 5-16	1
Tanks & Nuclear Weapons			T	N	#	#	N	T			Fig. 5-15	Fig. 5-16	1 & 2
		T	T	N	#	#	N	T	T		Fig. 5-15	Fig. 5-16	1 & 2
		T	N	N	#	#	N	N	T		Fig. 5-15	Fig. 5-16	1 & 2
★		T	M	M	#	#	M	M	T		Fig. 5-15	Fig. 5-16	1 & 2
Nuclear Weapons			*	*	#	#	*	*			For B43, 57 and 61		3
			*	N	#	#	N	*			Refer to T.O. 1F-111(B)A-25		3 & 4
			N	N	#	#	N	N			For SRAM Refer to		3 & 4
★			M	M	#	#	M	M			T.O. 1F-111(B)A-30		3 & 4
M-117A-1 or CBU-52B/B			6	4	⬚	⬚	4	6			Fig. 5-17	Fig. 5-18	3 & 4
			*	4	⬚	⬚	4	*			Fig. 5-17	Fig. 5-18	3 & 4
			6	6	⬚	⬚	6	6			Fig. 5-17	Fig. 5-18	3 & 4
			*	6	⬚	⬚	6	*			Fig. 5-17	Fig. 5-18	3 & 4

Legend:

T — 600 Gallon Fuel Tank

★ # — One or two B43, B61, B57, SRAM, or weapon bay fuel tanks in the weapon bay; one B43, B61, B57, or SRAM mixed with left weapon bay fuel tank in the weapon bay; one B43 or B61 mixed with one SRAM in the weapon bay. Any of these weapon bay loadings can be combined with any external nuclear loading or any external tank loading.

* — Unloaded weapon pylon and/or stub optional.

★ N — Nuclear weapon: B43, B57, B61 or SRAM.

M — Nuclear Mixes: B43 or B61 mixed with SRAM, either weapon can be carried on inboard pylon but only in symmetrical pairs.

⬚ — Weapons Bay Fuel Tank optional.

6 — Fully loaded BRU-3A/A rack.

4 — Mounted on BRU-3A/A outboard shoulder and bottom positions only.

Blank — Nothing installed.

NOTES:

1. Use of speed brake allowed for nominal 1 "g" (0.8 to 2.0 "g") flight at 16 to 25 degrees wing sweep (not to exceed 0.75 mach) and 26 degrees wing sweep (400 KIAS or 0.9 mach), whichever is less.
2. Carriage and release envelopes apply until tanks are released. For nuclear weapon carriage and release limits, refer to T.O. 1F-111(B)A-25 or T.O. 1F-111(B)A-30.
3. Use of speed brake allowed with weapon bay loading only when weapon bay doors are closed.
4. Use of speed brake allowed for nominal 1 "g" (0.8 to 2.0 "g") flight up to 400 KIAS or mach 0.9, whichever is lower, within carriage limits.

Refer to Stores Limitations, this section, for additional required limits affecting the above authorized stores loadings.

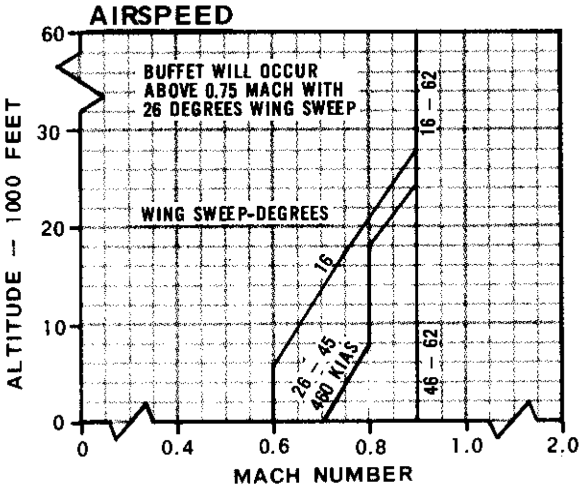
Figure 5-13.

Carriage Limits - Tanks

DATA BASIS: FLIGHT TEST
DATE: 31 MAY 1971

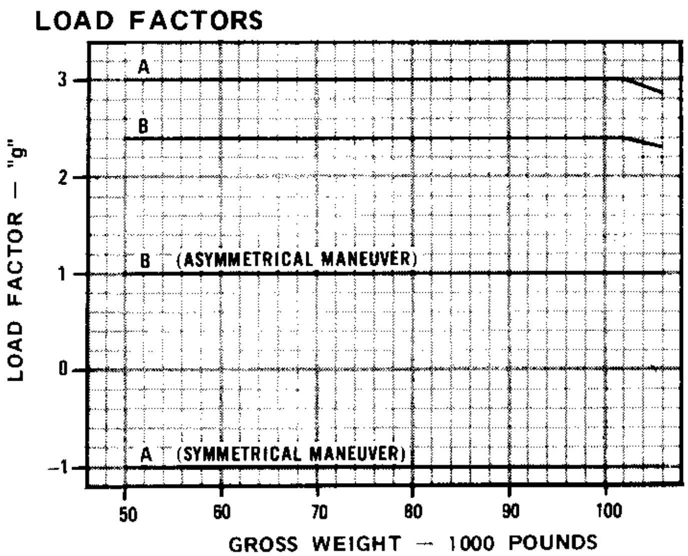
CONFIGURATION

(4) TANKS — 1 EACH ON 3, 4, 5 AND 6.



CAUTION

TANKS ON 4 AND 5 WILL CONTACT THE FUSELAGE AT WING SWEEPS AFT OF 62 DEGREES.



F0000000-F080 A

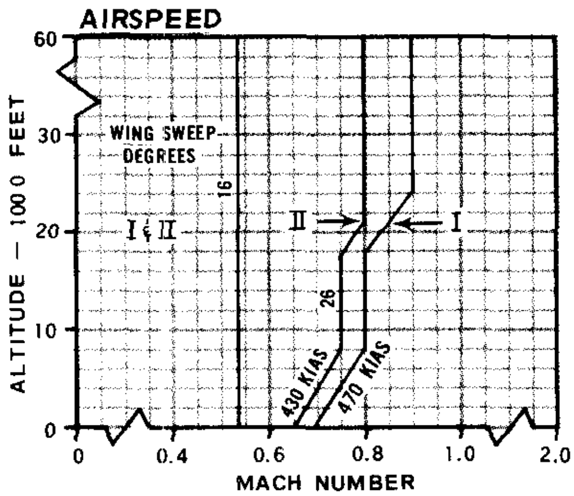
Figure 5-14. (Sheet 1)

Carriage Limits - Tanks

DATA BASIS: FLIGHT TEST
DATE: 31 MAY 1971

CONFIGURATION

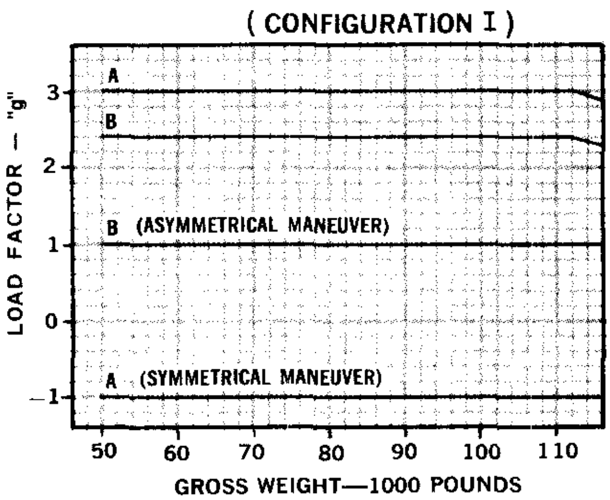
I (4) TANKS — 1 EACH ON 2, 3, 6 AND 7
BUFFET WILL OCCUR ABOVE 0.75 MACH.
II (6) TANKS — 1 EACH ON 2, 3, 4, 5, 6 AND 7.
BUFFET WILL OCCUR ABOVE 0.72 MACH

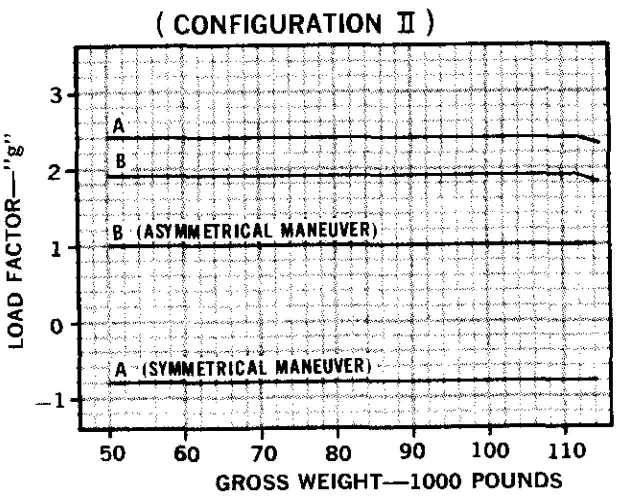


CAUTION

IF GROUND OPERATION NECESSITATES SWEEPING THE WINGS PAST 26 DEGREES, TANK-TO-TANK CONTACT WILL OCCUR AT WING SWEEPS GREATER THAN 43 DEGREES.

LOAD FACTORS





F0000000-F081A

Figure 5-14. (Sheet 2)

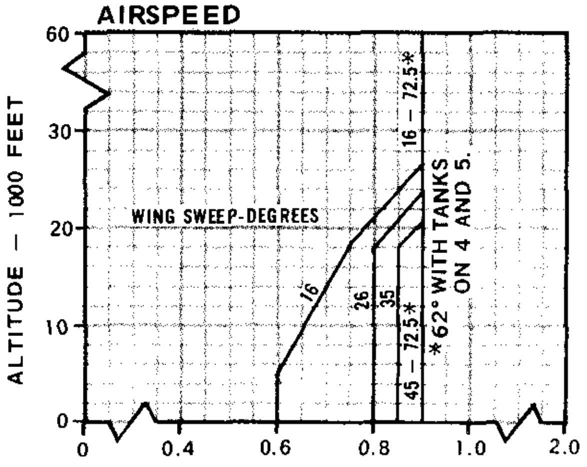
Carriage Limits - Tanks

(With or Without Nuclear Weapons on Other Stations)

DATA BASIS: FLIGHT TEST
DATE: 19 MAY 1972

CONFIGURATION

I (2) TANKS — 1 EACH ON 4 AND 5; OR
(2) TANKS — 1 EACH ON 3 AND 6 WITH OR WITHOUT
(2) B-43, 57 , 61 OR SRAM — 1 EACH ON 4 AND 5.



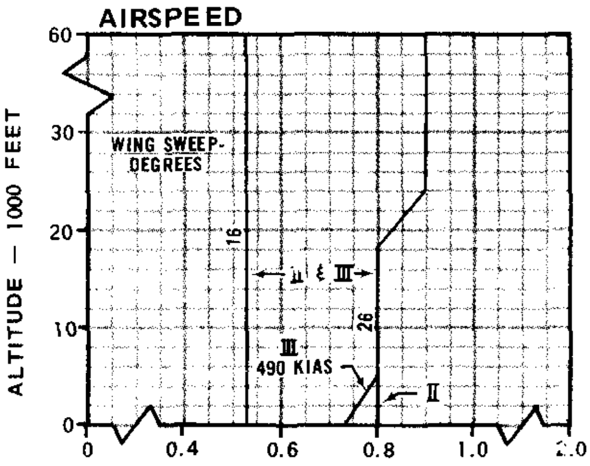
CAUTION

* TANKS ON 4 AND 5 MAY CONTACT THE FUSELAGE AT WING SWEEPS AFT OF 62 DEGREES DURING MANEUVERING FLIGHT.

CONFIGURATION

II (2) TANKS — 1 EACH ON 2 AND 7 WITH
(4) B-43, 57 , 61 OR SRAM ON 3, 4, 5 AND 6 OR
BUFFET WILL OCCUR ABOVE 0.72 MACH.

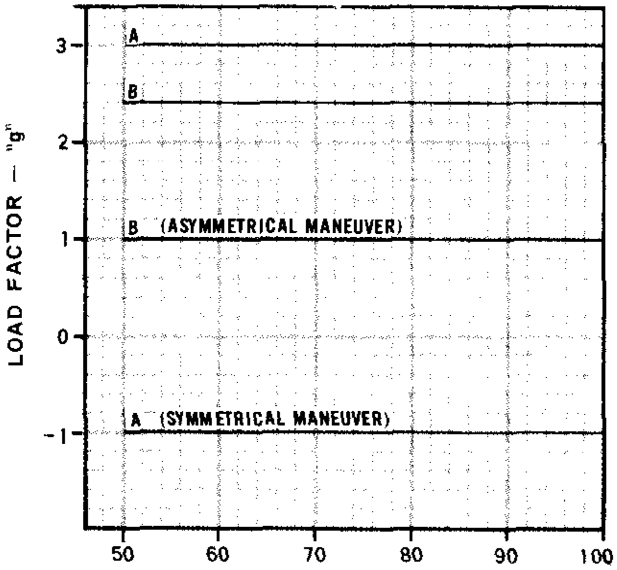
III (4) TANKS — 1 EACH ON 2, 3, 6 AND 7 WITH
(2) B-43, 57 , 61 OR SRAM — 1 EACH ON 4 AND 5.
BUFFET WILL OCCUR ABOVE 0.75 MACH.



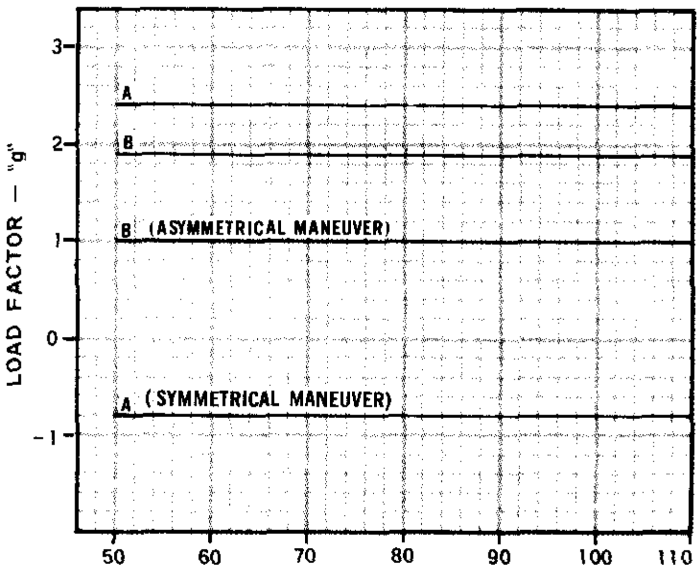
CAUTION

IF GROUND OPERATION NECESSITATES SWEEPING THE WINGS PAST 26 DEGREES, TANK-TO-TANK, OR TANK-TO-WEAPON CONTACT WILL OCCUR AT WING SWEEPS GREATER THAN 43 DEGREES.

LOAD FACTORS
(CONFIGURATION I AND III)



LOAD FACTORS
(CONFIGURATION II)



F0000000-F0828

Figure 5-15.

Release Limits - Tanks

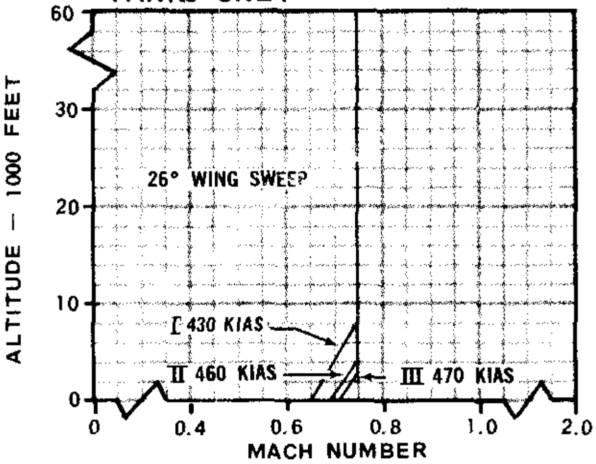
(With or Without Nuclear Weapons on Other Stations)

DATA BASIS: FLIGHT TEST
DATE: 19 MAY 1972

CONFIGURATION

I (6) TANKS — 1 EACH ON 2, 3, 4, 5, 6 AND 7.
II (4) TANKS — 1 EACH ON 3, 4, 5, AND 6.
III (4) TANKS — 1 EACH ON 2, 3, 6 AND 7.

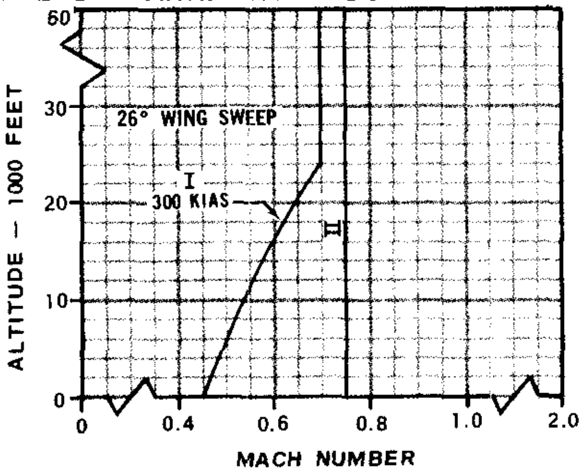
TANKS ONLY



CONFIGURATION

I (2) TANKS — 1 EACH ON 3 AND 6.
II (2) TANKS — 1 EACH ON 4 AND 5; OR
(2) TANKS — 1 EACH ON 2 AND 7 WITH
(4) B-43, 57 , 61 OR SRAM ON 3, 4, 5 AND 6 OR
(4) TANKS — 1 EACH ON 2, 3, 6, AND 7 WITH
(2) B-43, 57 , 61 OR SRAM — 1 EACH ON 4 AND 5.

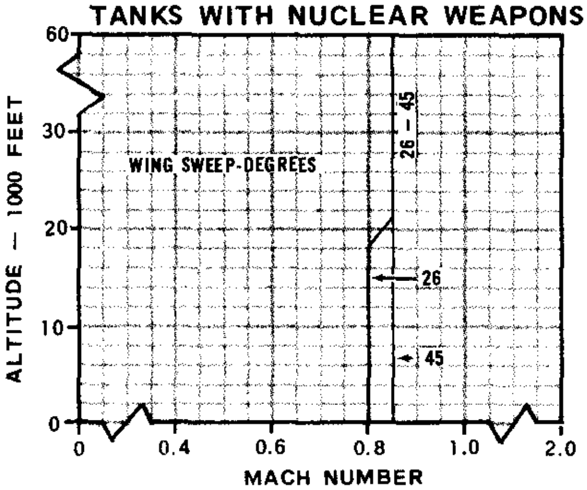
TANKS OR TANKS WITH NUCLEAR WEAPONS



CONFIGURATION

(2) TANKS — 1 EACH ON 3 AND 6 WITH
(2) B-43, 57 , 61 OR SRAM — 1 EACH ON 4 AND 5.

TANKS WITH NUCLEAR WEAPONS



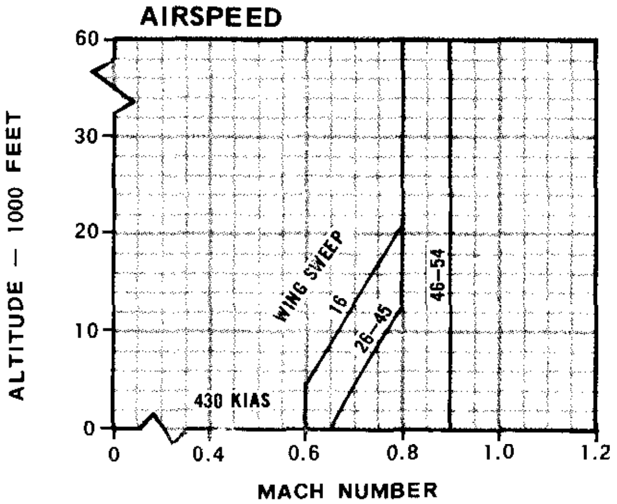
F0000000-F083B

Figure 5-16.

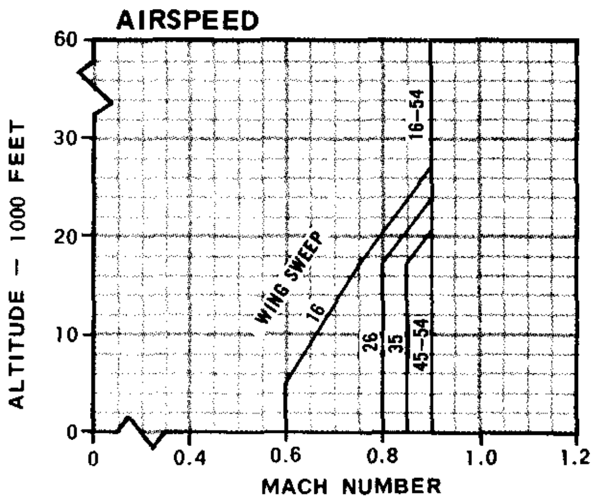
Carriage Limits - M-117A1 or CBU-52B/B

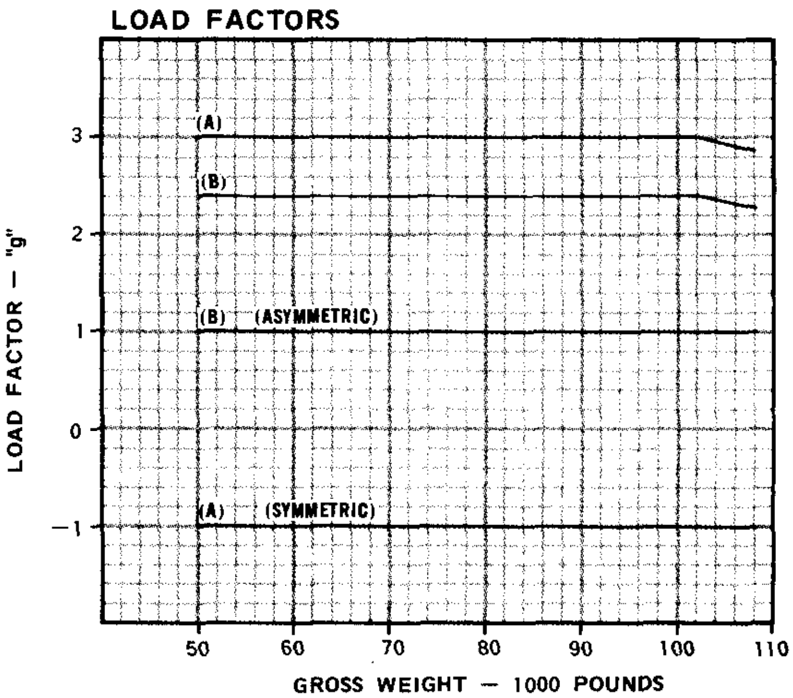
DATA BASIS: FLIGHT TEST
DATE: 19 MAY 1972

CONFIGURATION:
6 EACH ON 3, 4, 5 AND 6, OR
6 EACH ON 3 AND 6 AND
4 EACH ON 4 AND 5.



CONFIGURATION:
6 EACH ON 4 AND 5, OR
4 EACH ON 4 AND 5.





F0000000-F039

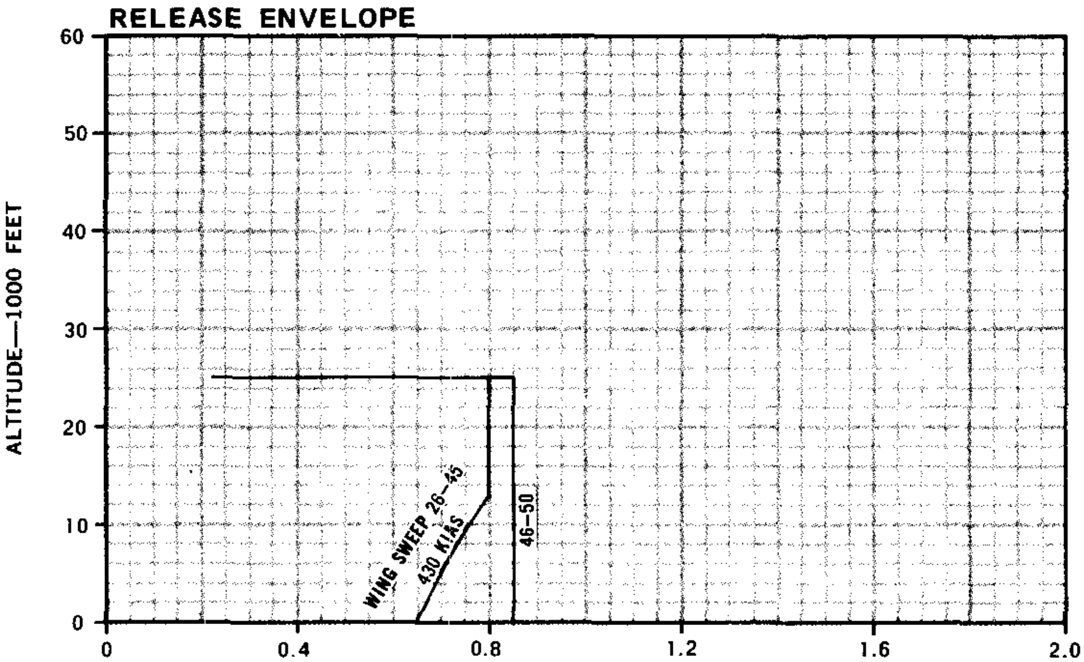
Figure 5-17.

Release and Jettison Limits - M-117A1 and CBU-52B/B

CONFIGURATION:

6 EACH ON 3 AND 6 AND 4 EACH ON 4 AND 5 (SLANT) OR
4 EACH ON 4 AND 5 (SLANT), W PYLONS ON 3 AND 6.

NOTE: FOR THE 4 WEAPONS PER BRU LOADING THE WEAPONS MUST BE LOADED ONLY ON THE BRU CENTERLINE AND OUTBOARD SHOULDER POSITIONS.



RELEASE LIMITATIONS

PARAMETERS	M-117A1 AND CBU-52B/B
SPEED BRAKE	RETRACTED
WING SWEEP	SEE FIGURE ABOVE
ALTITUDE—FEET	0 TO 25,000
DIVE ANGLE	0 DEGREES TO 15 DEGREES
CLIMB ANGLE	0 DEGREES TO 15 DEGREES
ROLL ANGLE	±5 DEGREES
ROLL RATE	ZERO
NORMAL "G"	+0.8 TO +2.0

M-117s MUST HAVE MAU-103A/B FIN ASSEMBLY.

- THE RELEASE MODE FOR WEAPONS ON STATIONS 3, 4, 5 AND 6 ARE: OUTBOARD TO INBOARD ONLY, TRAIN—FROM PAIRS OF PYLONS.

EMERGENCY JETTISON LIMITS:

- WING SWEEP — NOT TO EXCEED 26 DEGREES.
- ALTITUDE — 10,000 FEET OR BELOW.
- AIRSPEED — NOT TO EXCEED 250 KIAS.
- FLAPS/SLATS — EXTENDED OR RETRACTED.

FOR EMERGENCY JETTISON PROCEDURES REFER TO APPLICABLE WEAPON DELIVERY MANUAL.

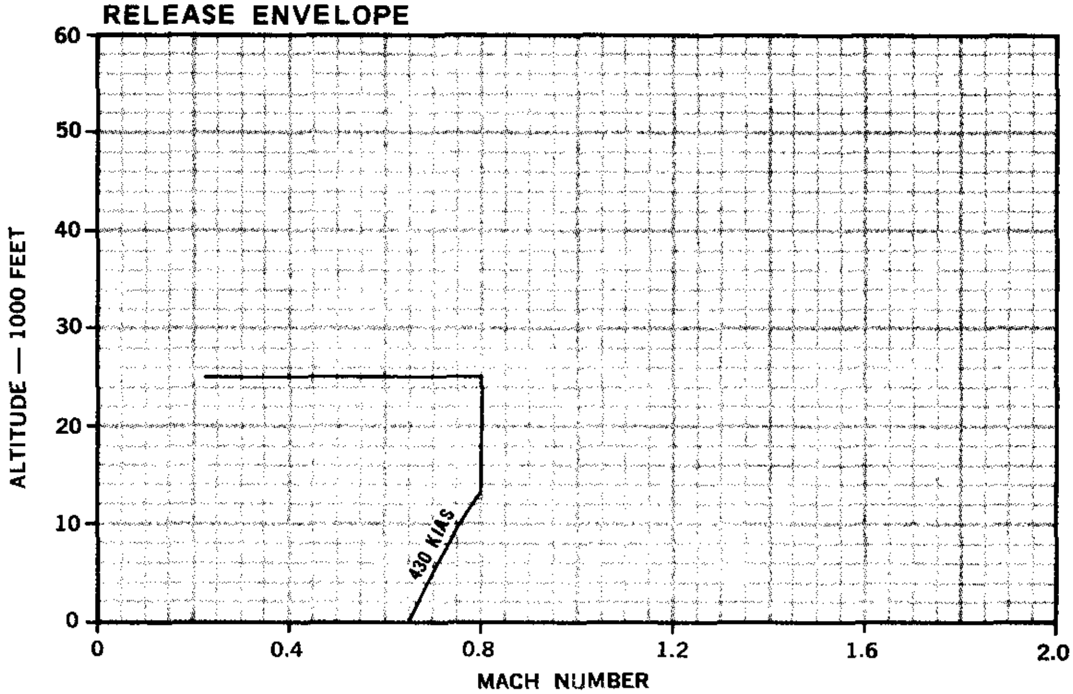
F0000000-F040

Figure 5-18. (Sheet 1)

Release and Jettison Limits - M-117A1 and CBU-52B/B

CONFIGURATION:
6 EACH ON 3, 4, 5 AND 6 OR
6 EACH ON 4 AND 5 WITH EMPTY PYLONS AT 3 AND 6

RELEASE ENVELOPE



RELEASE LIMITATIONS

PARAMETERS	M-117A1 AND CBU-52B/B
SPEED BRAKE	RETRACTED
WING SWEEP	26 DEGREES
ALTITUDE— FEET	0 TO 25,000
DIVE ANGLE	0 DEGREES TO 15 DEGREES
CLIMB ANGLE	0 DEGREES TO 15 DEGREES
ROLL ANGLE	±5 DEGREES
ROLL RATE	ZERO
NORMAL "G"	+0.8 TO +2.0

M-117s MUST HAVE MAU-103A/B FIN ASSEMBLY

- THE RELEASE MODE FOR WEAPONS ON STATIONS 3, 4, 5 AND 6 ARE: OUTBOARD TO INBOARD ONLY, TRAIN — FROM PAIRS OF PYLONS.

EMERGENCY JETTISON LIMITS:
- WING SWEEP — NOT TO EXCEED 26 DEGREES.
- ALTITUDE — 10,000 FEET OR BELOW.
- AIRSPEED — NOT TO EXCEED 250 KIAS.
- FLAPS/SLATS — EXTENDED OR RETRACTED.

FOR EMERGENCY JETTISON PROCEDURES
REFER TO APPLICABLE WEAPON DELIVERY MANUAL.

F0000000-F052A

Figure 5-18. (Sheet 2)

This is the last page of Section V.

SECTION VI

FLIGHT CHARACTERISTICS

Note

The airspeed indicated on the airspeed mach indicator has been calibrated for pitot-static system errors by the CADC and therefore is actually KCAS (knots calibrated airspeed). However, this air speed is referred to as KIAS (knots indicated airspeed) throughout this manual since it is read directly from the instrument.

TABLE OF CONTENTS.

INTRODUCTION.

The information presented in this section reflects the expected flight characteristics with and without the basic 600 gallon tank and weapon loadings. Flight characteristics with external store loadings are based primarily on estimations supplemented where possible by limited flight test experience. Detailed stability and control flight testing with the basic external store loadings has not yet been completed. Utilization of the variable sweep concept has not resulted in unusual flight characteristics. The main features of the flight control system (self adaptive gain changing and command augmentation) significantly minimizes variations in stability and control characteristics over the large mach-altitude operating spectrum of the aircraft. The low friction and breakout forces associated with the flight control system enhance ease of handling and maneuverability. Wing sweep transition will not be reflected to the pilot in the form of a trim change due to the series trim feature of the flight control system which acts as an automatic trim system. At a fixed mach-altitude condition, wing sweep transition will be noticed only by the increase in aircraft angle-of-attack and attitude for an aft movement of the wing. For a forward movement of the wing, a decrease in angle-of-attack and attitude will occur.

FLIGHT CONTROL SYSTEM.

For a detailed description of the flight control system refer to "Flight Control System," Section I.

DEFINITION OF LONGITUDINAL REFERENCE ANGLES.

An illustration describing flight path angle, pitch angle, angle of incidence, angle-of-attack and relative wind is presented in figure 6-1.

ANGLE-OF-ATTACK.

The angle-of-attack indication system provides an indication of the angular position of the wing chord in relation to the aircraft flight path. Angle-of-attack is of primary importance since, for a given aircraft weight and airspeed, sufficient lift can be generated to maintain one "g" flight only at a particular angle-of-attack. That is, lift is a function of airspeed and angle-of-attack. Thus, at one "g" flight if airspeed is held constant, angle-of-attack will remain constant. If airspeed decreases, angle-of-attack must increase if one "g" flight is to be maintained. Conversely, if airspeed increases, angle-of-attack must decrease to maintain one "g" flight. This direct relationship of angle-of-attack and airspeed with lift allows angle-of-attack to

Longitudinal Reference Angles

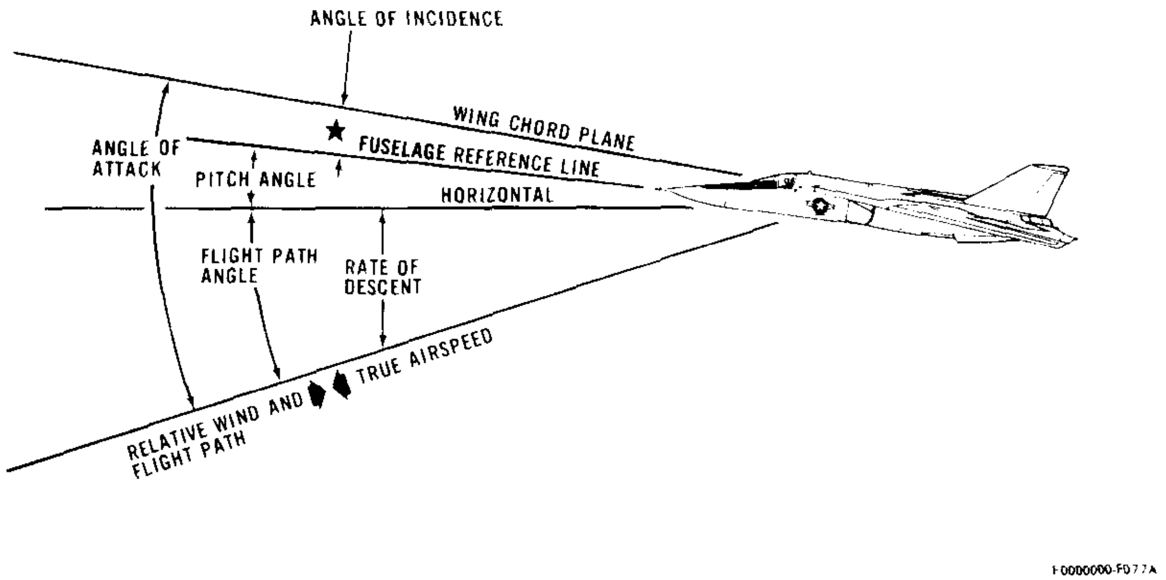


Figure 6-1.

be used in place of airspeed. Angle-of-attack can be held constant and calibrated airspeed will remain relatively constant varying in proportion to gross weight but remaining essentially independent of altitude. Further, rate of descent or climb can be controlled by power changes and airspeed will remain constant as long as angle-of-attack remains constant. During normal landings, the recommended approach is 10.0 degrees angle-of-attack regardless of gross weight. The angle-of-attack indexer is programmed so that the on-speed symbol is lighted in the range of 10 degrees (± 1.0°).

LEVEL FLIGHT CHARACTERISTICS.

Refer to Section II for discussion of takeoff and landing characteristics.

SUBSONIC FLIGHT.

Operation of the aircraft at subsonic speeds up to mach 0.80 should normally be accomplished with a wing sweep of 26 to 50 degrees. Generally, response and damping about all axes in this speed range is considered excellent based on flight experience to date. Rolling maneuvers in the subsonic region (airspeeds greater than 250 KIAS but less than mach 0.80) at wing sweeps aft of 45 degrees are not recommended due to the fact that the spoilers are locked out aft of this wing sweep. With the spoilers locked out, roll control is significantly reduced and, therefore, aircraft roll performance is reduced. If flight is required at wing sweeps aft of 45 degrees, uncoordinated rolling maneuvers should not exceed 60 degrees of bank and coordinated rolls should not exceed 360 degrees of roll (at maximum roll rate) to prevent excessive sideslip angles from being developed. Excessive sideslip angles tend to reduce the aircraft roll performance and may in some 360 degree rolls reduce the roll rate to values which may appear to the pilot as if the aircraft has ceased rolling. However, all other characteristics of the aircraft are considered good at the aft sweep angles. The angle-of-attack limits presented in Section V should not be exceeded in either 1 "g" or maneuvering flight. Based upon these angle-of-attack limits, recommended minimum flying speeds for 1 "g" and limited maneuvering flight are presented for nominal center-of-gravity positions associated with automatic fuel sequence. (See "Minimum Recommended Flying Speeds" this section.) The minimum recommended flying speeds will vary as much as one knot from these values for each one percent MAC center-of-gravity deviation from the quoted values. These minimum

recommended flying speeds are for operational planning purposes only, and the angle-of-attack limits presented in Section V should not be exceeded in either 1 "g" or maneuvering flight.

WARNING

Under no circumstances should the angle-of-attack limits be exceeded. Possible inadvertent stall and post-stall gyrations could result from exceeding these limits.

TRANSONIC FLIGHT.

During operation of the aircraft at transonic mach numbers (mach 0.80 to 1.10) wing sweep angles of 45 to 72.5 degrees should be utilized. Refer to Section V for flight limitations with external stores. At 20,000 feet and above, sweep angles of 45 degrees are recommended to keep the aircraft angle-of-attack low which will result in better acceleration characteristics. At the lower altitudes, more aft sweep angles are recommended to optimize acceleration. Although the spoilers will be locked out with the more aft sweeps, roll performance will be improved due to the lower angle-of-attack and higher dynamic pressure. During transonic flight above 25,000 feet a relatively small directional trim change may occur just prior to achieving supersonic flight. As altitude is decreased in this speed regime, the trim change is more noticeable and below 10,000 feet may be exhibited as a small Dutch roll transient accompanied by mild buffet. No trim changes occur longitudinally or laterally. The exact cause of this characteristic is not known at this time, but will be investigated further. Predicted longitudinal short period characteristics for a wing sweep of 50 degrees at low altitude-high-transonic and low supersonic speeds indicate that the short period will have a frequency of approximately 1.0 to 1.2 cycles per second. Operation in these flight conditions should be avoided through the utilization of sweep angles at or near the maximum sweep angle.

SUPERSONIC FLIGHT.

Flight in the supersonic flight spectrum (mach 1.10 and above) should normally be accomplished with the wings fully swept. Some external store loadings preclude full aft sweep and as such are limited to 54 degrees. Flight can be performed in the supersonic speed range with wing sweep angles as low as 50 degrees; however, such sweep angles are detrimental to optimum performance. Deceleration at supersonic speeds can be greatly enhanced by sweeping the wing forward to obtain increased drag. This allows the pilot to either pull power back to aid deceleration or maintain power for more rapid acceleration should the need arise. During wing sweeping and ensuing deceleration or acceleration, aircraft trim changes will be small and will appear to the pilot principally as attitude changes. Throughout the supersonic flight spectrum covered to date, response and damping characteristics have been good.

CAUTION

As the wings are swept forward, exercise caution to avoid exceeding the speed limitations or computed MSMA indications which apply to the forward wing sweep positions, especially wing sweep angles less than 50 degrees. Refer to "Airspeed Limitations" and "Stores Limitations," Section V.

MANEUVERING FLIGHT CHARACTERISTICS.

LONGITUDINAL FLIGHT.

Wing sweep angles for maneuvering flight are compatible with those previously described for level flight characteristics. During flight with the slats and flaps extended, longitudinal maneuvering should not be allowed to exceed an angle-of-attack of 14 degrees to preclude the entrance to a stall. The stall warning system will activate at an angle-of-attack of 14 degrees. During flight with the slats and flaps retracted, to preclude entrance to a stall, longitudinal maneuvering should not be allowed to exceed the angle-of-attack limits in Section V.

WARNING

If airspeed decreases during maneuvering flight, the command augmentation feature of the flight control system can produce an increase in angle-of-attack without additional back stick input by the pilot. Angle-of-attack must therefore be monitored and controlled while maneuvering to insure that the limits are not exceeded.

During pullups or turns at high speed with slats and flaps retracted, the stick force per "g" is relatively independent of wing sweep and altitude. A mild variation with mach number, however, does exist. Stick

deflection per "g" also exhibits the same basic characteristics. During supersonic flight at altitudes above 30,000 feet with aft wing sweeps, full back longitudinal control maneuvers can result in some stick "talk-back" being detected. This characteristic is a result of the pitch damper and mechanical input attaining full noseup surface authority. Excessive rate of longitudinal control application will make this characteristic more apparent; therefore, smooth application of control is recommended. Loss of pitch damping in one direction will result but may be restored by relieving the back pressure being held. This same characteristic is exhibited at negative load factors for the aft sweep throughout its operational flight envelope.

BUFFET.

Aerodynamic buffet of the airframe is caused by the oscillatory separation and reattachment of the airflow over some portion of the aircraft surface, usually the wing. The separated flow may be due to ordinary stalling over local areas or may be induced by a shock wave caused by local flow reaching sonic velocity. Buffet onset is encountered at moderate to high altitudes in the subsonic to low supersonic speed region. This onset is dependent on flight condition and varies with wing sweep. The data presented herein relative to buffet define the onset (±0.05 "g") only. This onset is not and should not be interpreted as a flight limitation from either structural or operational standpoint. Onset is merely an initial "feel" of buffet and does not define allowable or bearable intensity which must be determined, by pilot comfort or other considerations. In the lower wing sweep angles (26°) the intensity increases quite rapidly as load factor or angle-of-attack passes buffet onset conditions, while in the 72.5 degree wing sweep position there is a much slower intensity rise with increasing load factor and the intensity generally does not exceed light buffet (±0.10 "g" to 0.15 "g") at any angle-of-attack up to approximately 20 degrees. Since the altitudes at which buffet occurs are above those for optimum cruise conditions they should be avoided for normal cruise operation. Figure 6-2 presents the angle-of-attack for buffet onset determined from flight test data for the clean configuration. These boundaries are based on ±0.05 "g" buffet intensity.

WING SWEEP-MANEUVERABILITY EFFECTS.

Instantaneous longitudinal maneuver capability for wing sweeps of 26, 54, and 72.5 degrees, clean configuration, and with or without external stores or tanks is presented in figure 6-3. For sustained maneuver load factors, refer to Appendix I. Two typical gross weights are shown: 70,000 and 90,000 pounds. The maneuver capability is based on: an angle-of-attack of 15 degrees for a wing sweep of 26 degrees and an angle-of-attack

Angle-Of-Attack For Buffet Onset

DATA BASIS: FLIGHT TEST
DATE: 19 MAY 1972

CONFIGURATION:
GEAR AND FLAPS UP

FUEL GRADE: JP-4
ENGINES: TF30-P-7

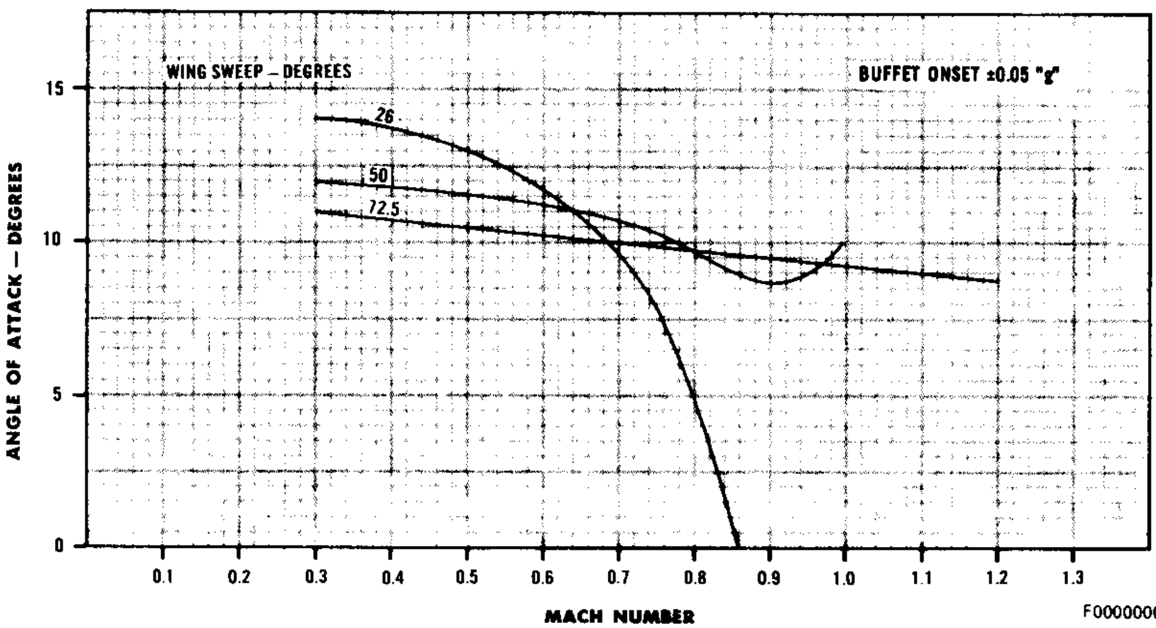
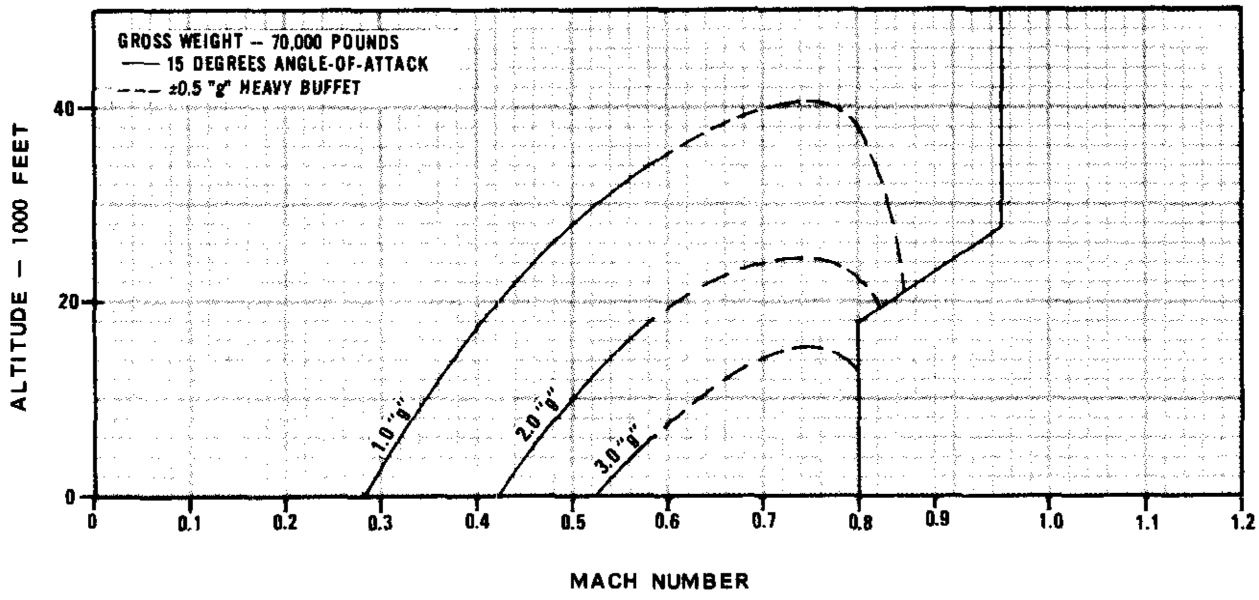


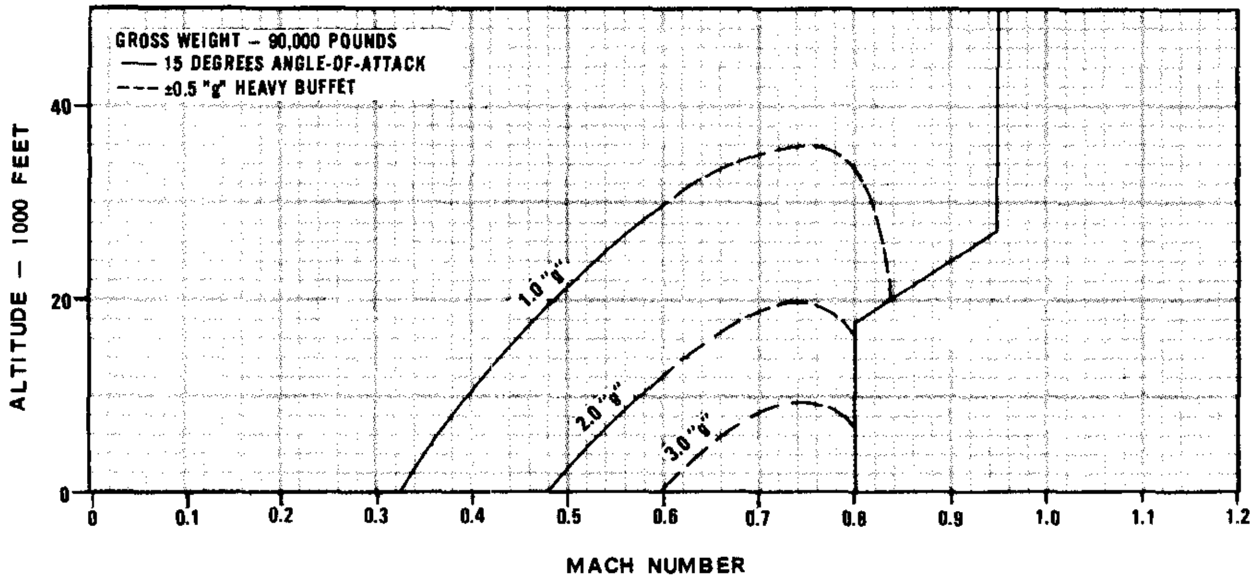
Figure 6-2.

Longitudinal Maneuver Capability

DATA BASIS: ESTIMATED
DATE: 1 AUGUST 1969

CONFIGURATION:
WING SWEEP–26 DEGREES
GEAR AND FLAPS UP
WITH OR WITHOUT B–43
WEAPONS AND 600 GALLON
TANKS





F0000000-F088

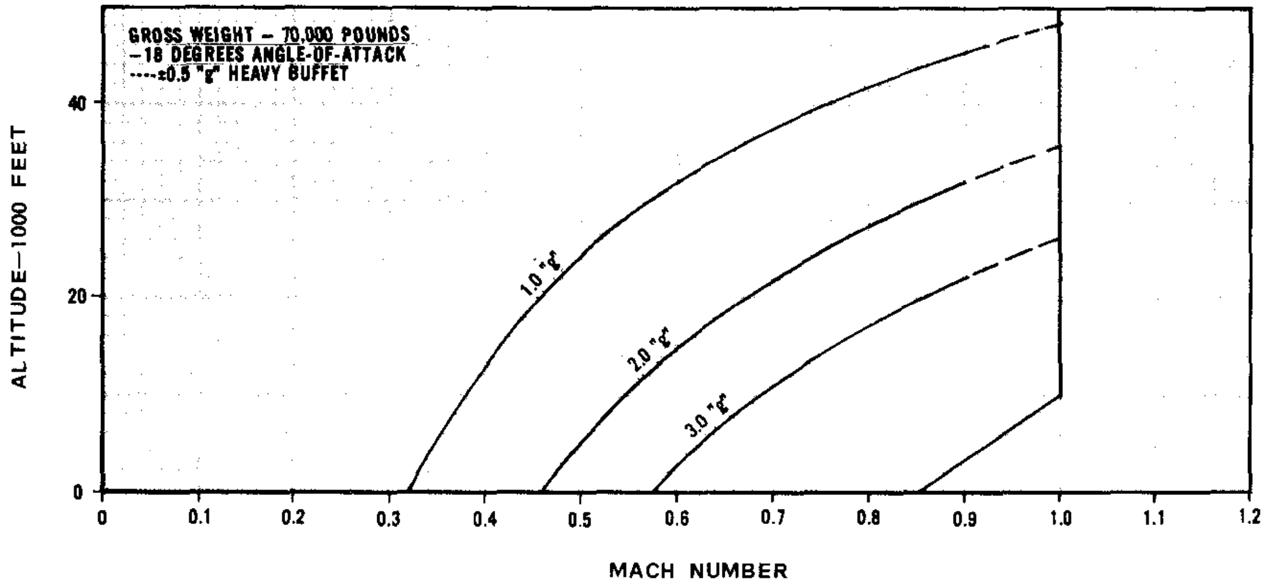
Figure 6-3. (Sheet 1)

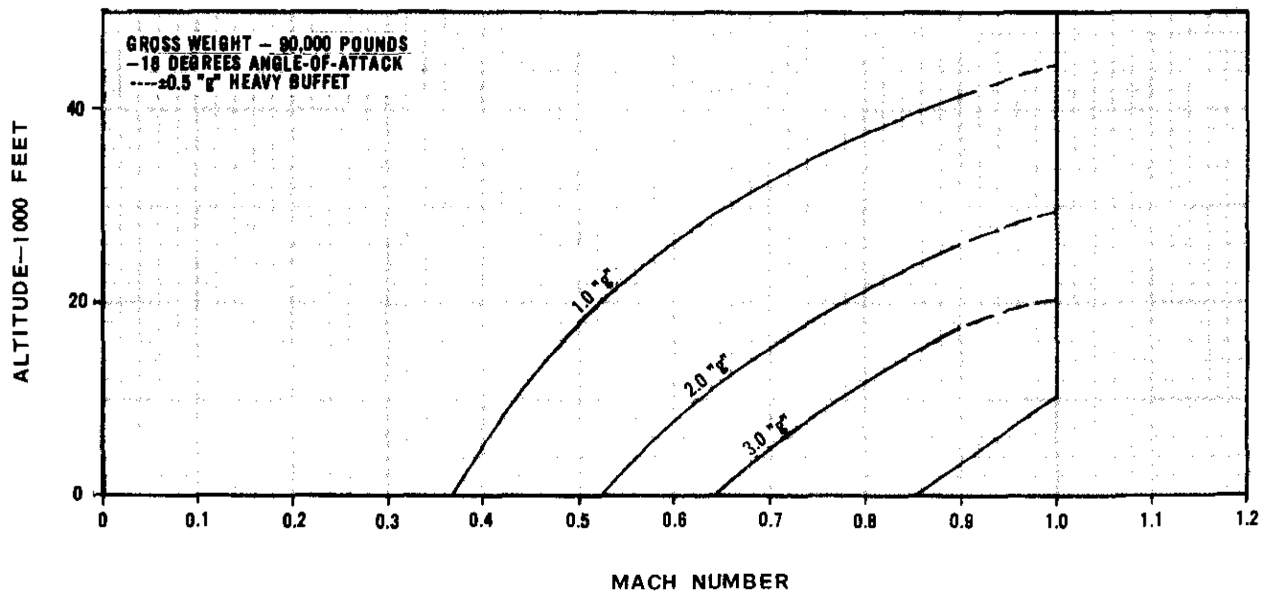
Longitudinal Maneuver Capability

DATA BASIS: ESTIMATED
DATE: 1 AUGUST 1969

CONFIGURATION:

WING SWEEP — 54 DEGREES
GEAR AND FLAPS UP
WITH OR WITHOUT B-43 WEAPONS
AND 600 GALLON TANKS





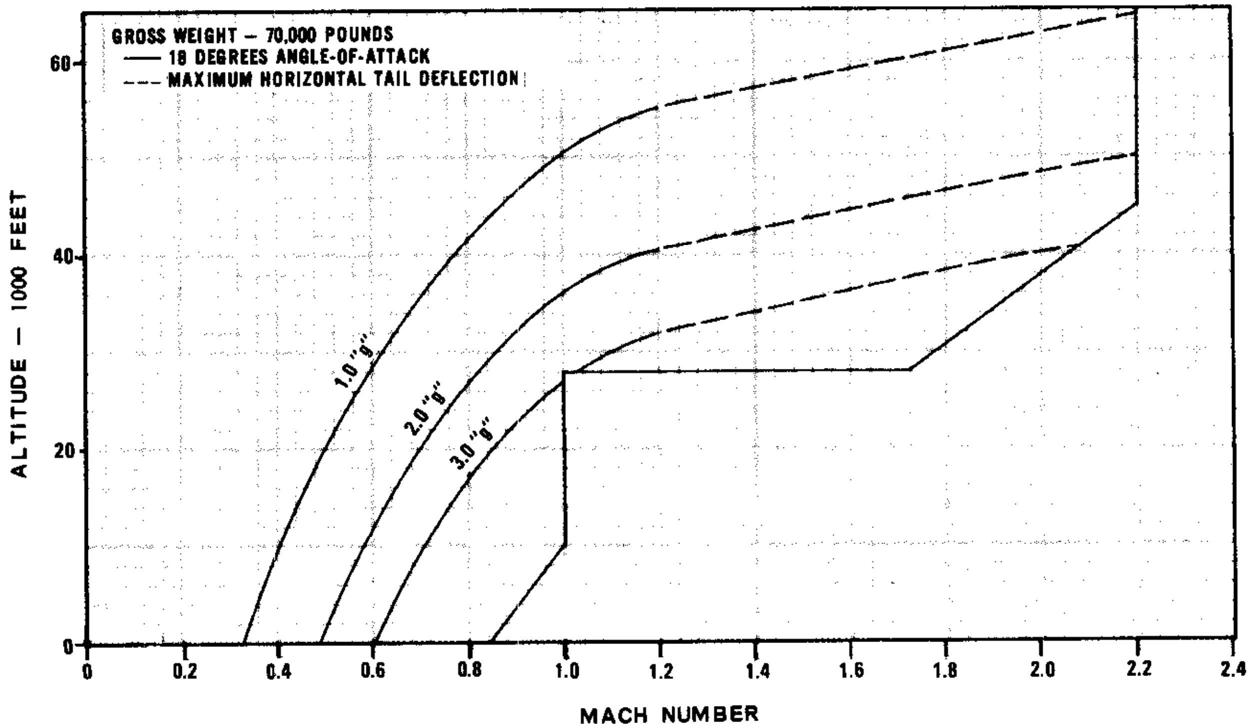
F0000000-F089

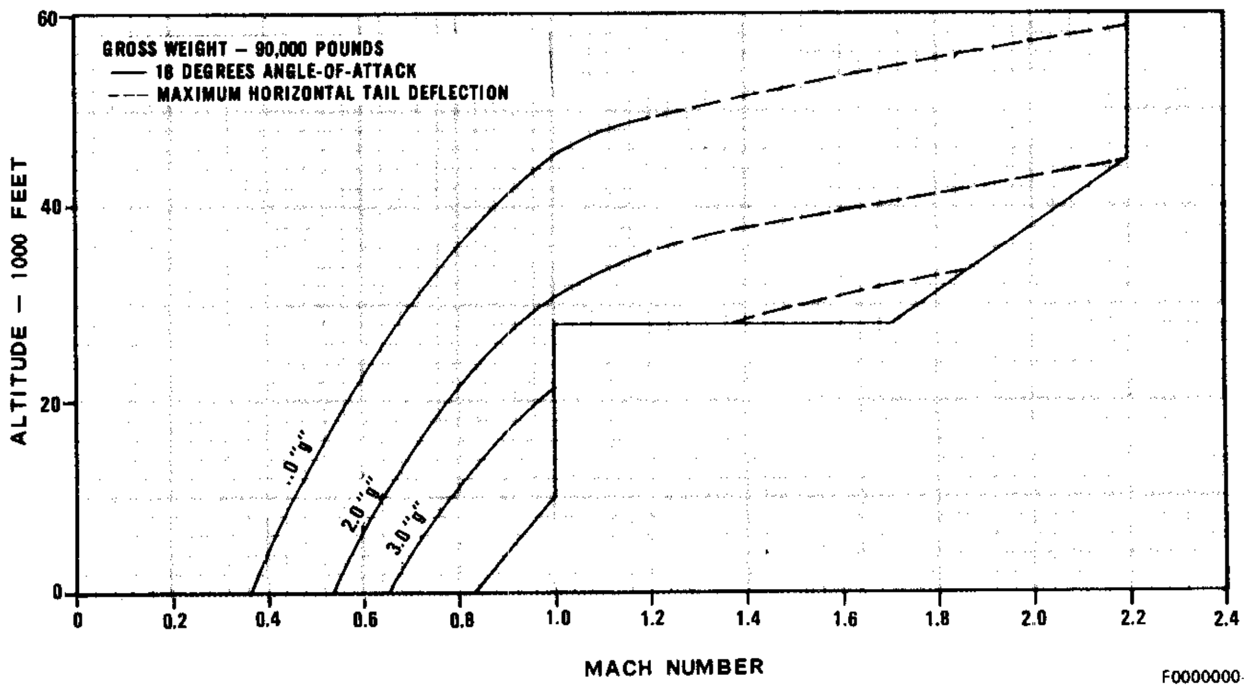
Figure 6-3. (Sheet 2)

Longitudinal Maneuver Capability

DATA BASIS: ESTIMATED
DATE: 1 AUGUST 1969

CONFIGURATION:
WING SWEEP–72.5 DEGREES
GEAR AND FLAPS UP
WITH OR WITHOUT B-43
WEAPONS AND 600 GALLON
TANKS





F0000000-F090

Figure 6-3. (Sheet 3)

of 18 degrees for wing sweeps of 54 and 72.5 degrees; heavy buffet (±0.5 "g"); and maximum longitudinal control deflection. The heavy buffet line is predicated on extremely limited flight test data.

WARNING

Flight into heavy buffet is prohibited.

In the mach 0.80 to 1.10 range in maneuvering flight, a wing sweep of 54 degrees is recommended to obtain the best overall buffet free maneuvering margin. Figure 6-4 presents, at a typical high subsonic speed (mach 0.80), the angle-of-attack versus wing sweep required to develop various load factors at sea level and 27,500 feet for a high gross weight. It should be noted that at the forward wing sweep of 26 degrees, buffet onset occurs at a relatively low angle-of-attack. As the wing is swept aft, the buffet onset margin improves until the wing is at 54 degrees. Aft of this sweep the buffet onset margin does not increase.

ROLLING FLIGHT.

Clean configuration roll rates up to about 160 degrees per second may be attained with lateral stick forces of fifteen pounds. Normal rolling performance below mach 0.80 decreases significantly when the wings are swept aft of 45 degrees because the spoilers become inoperative. In addition, considerable adverse yaw occurs during low subsonic speed rolling maneuvers, especially when rolls through large bank angle changes at high rates are accomplished. This is particularly apparent when the flaps are extended and/or the aircraft is operating at relatively high angles-of-attack (above 10 degrees). This yawing characteristic is manifested by the aircraft nose moving in a direction opposite to the roll.

WARNING

At high speeds during maximum rolling maneuvers, abrupt forward stick motion should not be made to preclude rapid buildup in roll rate due to roll/yaw coupling.

FLIGHT WITH DAMPERS OFF.

The probability of flight without the basic stability augmentation systems in either of the pitch, roll, or yaw channels is extremely remote. Basic redundancy, failure monitoring, and self-test of the system enhance the full time operation of the system. In the event of a flight control system malfunction necessitating turning the pitch, yaw, or roll damper off in flight, the aircraft speed should be reduced to the applicable augmentation off operating limit in Section V and the affected damper turned off. Transonic deceleration should be conducted as rapidly as possible under VFR conditions if practicable. The speed brake should not be used during transonic deceleration and no attempt should be made to reduce any associated small lateral-directional oscillations. Continuing flight should be accomplished with a wing sweep of 26 degrees observing the augmentation off operating limitations for this sweep and landing should be accomplished as soon as practical.

WARNING

During flight with pitch, yaw, or roll damper off, large and/or abrupt stick and/or rudder inputs should be avoided in the damper off axis. Lateral maneuvers should be limited to 60 degree bank angle.

The following discussion is presented to point out those pertinent characteristics of the aircraft that the pilot should know.

SLATS AND FLAPS EXTENDED.

Loss of the pitch damper will result in degraded damping characteristics, as a result, airspeed control on final approach will become more difficult and increased pilot attention to maintaining angle-of-attack will be required. Reduced speed stability will be noticed by the pilot with attendant lower maneuver force gradients. Loss of the yaw damper will result in degraded damping characteristics and loss of the adverse yaw compensation. As a result, excessively large sideslip angles can be developed during abrupt lateral inputs. Such inputs should be avoided. Loss of roll damper will result in degraded roll damping which is not considered serious. Loss of roll trim will also occur but can be compensated for by trimming the aircraft with the rudder.

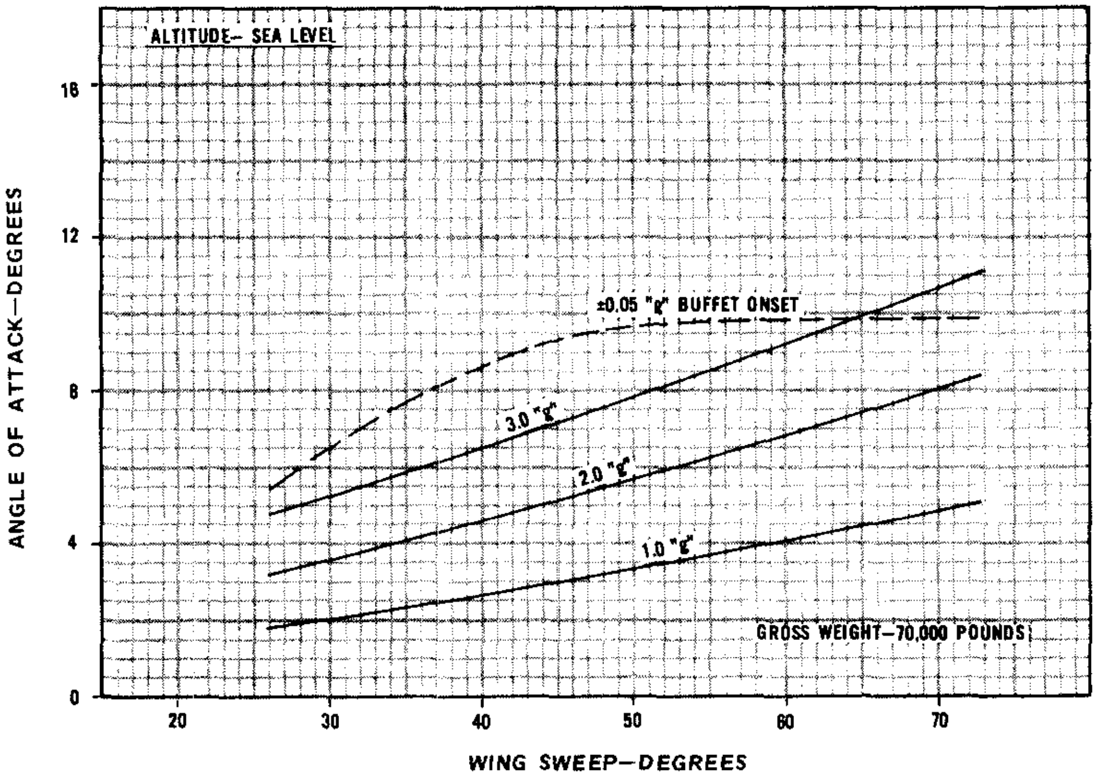
Note

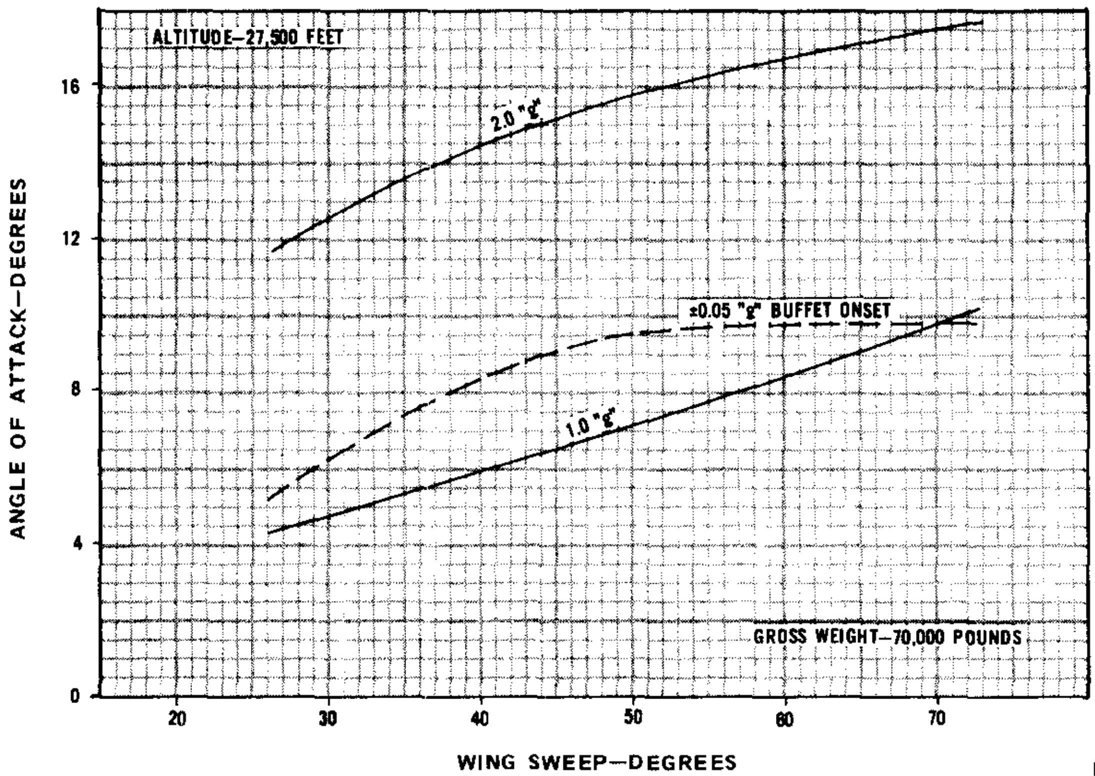
In the event the pitch damper or yaw damper is off at landing, perform a "straight-in" approach at an angle-of-attack of 10 degrees. Avoid abrupt longitudinal and/or lateral control inputs. Approaches with the pitch damper off will require increased pilot attention to airspeed and angle-of-attack control.

Wing Sweep Maneuverability Effects

DATA BASIS: ESTIMATED
DATE: 1 AUGUST 1969

CONFIGURATION:
NO EXTERNAL STORES
MACH—0.80
GEAR AND FLAPS UP
SLATS RETRACTED





F0000000-F091A

Figure 6-4.

SLATS AND FLAPS RETRACTED.

Loss of the pitch damper will result in degraded damping characteristics as well as the loss of the command augmentation system. Much larger variations in stick force per "g" will be reflected to the pilot. Flight in given portions of the operating spectrum is restricted due to low stick force per "g" (less than 3 pounds per "g"). With the combination of low damping, stick force per "g" and short period oscillation characteristics, the pilot may be susceptible to pilot induced oscillations. Loss of the yaw damper will result in low Dutch roll damping. This is most pronounced at high supersonic speeds above mach 1.50. Roll inputs should be minimized to preclude excitement of the Dutch roll mode. Attempts to damp the Dutch roll mode through pilot rudder inputs should be minimized to prevent getting in-phase with the oscillations and causing the aircraft to enter a sustained oscillation. Loss of the roll damper will result in degraded damping as well as loss of the command augmentation and roll trim systems. Roll inputs with aft wing sweeps at supersonic speeds should be minimized. Basic aircraft roll damping can be augmented by sweeping the wings forward to 50 degrees at supersonic speeds. Roll trim can be accomplished by using rudder trim.

MINIMUM AIRSPEEDS.

WARNING

- Under no circumstances should the angle-of-attack limits or stall warning activation be exceeded. Possible inadvertent stall and post-stall gyrations will result from exceeding these limits.
- Minimum airspeeds shown in figure 6-5, sheets 1 and 2, are presented to show the lowest airspeeds that may be obtained within the current angle-of-attack limits and do not reflect thrust available. In most cases the drag at this minimum airspeed approaches or exceeds thrust available. Rapid decreases in speed and increases in angle-of-attack can result in high sink rates and/or loss of control.

SLATS AND FLAPS EXTENDED.

For the aircraft with the slats and flaps extended, the minimum airspeed is based on a wing angle-of-attack of 14 degrees. Figure 6-5 presents these speeds for 1 "g" flight and for a bank angle of 30 degrees. The indicated minimum airspeeds are representative of normal fuel sequencing within the gross weight range.

Note

At center-of-gravity positions forward of 41 percent with no external stores or forward of 39 percent with external stores and 26 degrees wing sweep, sufficient elevator may not be available to arrest sink rate due to longitudinal control power limiting.

SLATS AND FLAPS RETRACTED.

For the aircraft with the slats and flaps retracted, the minimum airspeed is based on a wing angle-of-attack of 15 degrees for wing sweeps of 16 through 49 degrees and a wing angle-of-attack of 18 degrees with wing sweeps of 50 through 72.5 degrees. Figure 6-5 also presents these speeds for 1 "g" flight and 2 "g" flight (60 degrees bank). These speeds are based on center-of-gravity positions representative of normal fuel sequencing.

THRUST REQUIREMENTS.

Particular attention to thrust requirements versus airspeed is essential in this aircraft because of its variable sweep wing, sharp drag rise at high angles-of-attack (typical of aircraft with high wing loading), relatively slow thrust buildup during engine acceleration, and because of the nature of the flight control system. Figure 6-6 shows how thrust required and thrust available change at different airspeeds for a typical wing sweep and gross weight with flaps and slats retracted. Thrust required can be defined as the amount of thrust needed to sustain present airspeed, altitude and "g." The pilot must be aware of the rapid drag rise, or increase in thrust requirement that exists at higher angles-of-attack. This drag rise (the steep slope in the left side of the thrust required curve) which occurs over a small range of airspeeds, can lead to loss of control unless it is recognized and corrected.

The thrust required curve has been drawn as a heavy line to the left of the lowest point and a light line to the right of the lowest point. These two parts of the thrust required curve will be considered separately, because the aircraft behaves differently on each part. The heavy-lined portion is known as "the backside of the thrust required curve" and the light portion as "the frontside of the curve." Changes in thrust, "g," airspeed, gross weight and configuration significantly affect the flying qualities of the F-111, especially at high angles-of-attack. Each of these changes will be discussed separately.

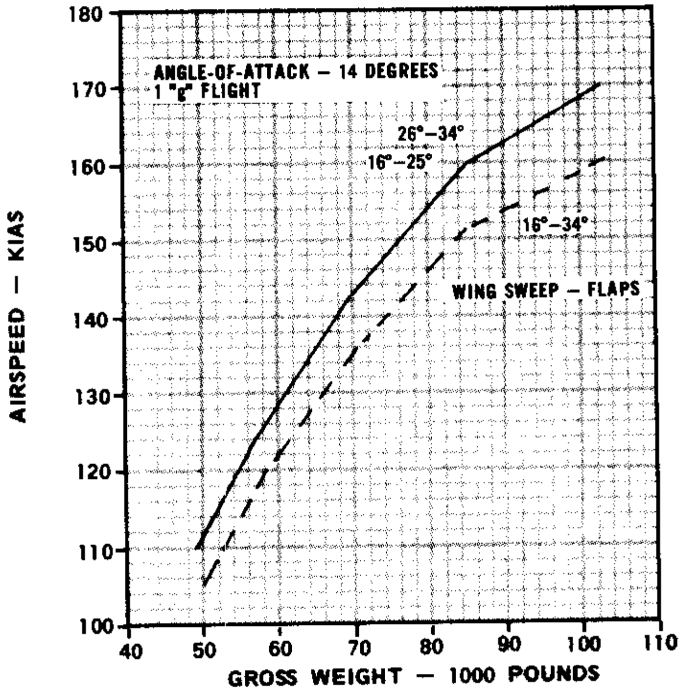
Minimum Airspeeds

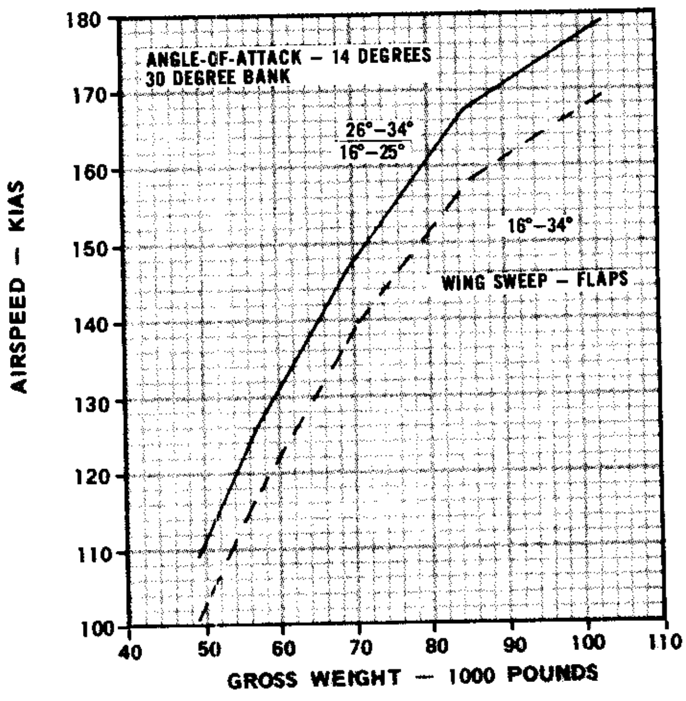
DATA BASIS: FLIGHT TEST
DATE: 19 MAY 1972

CONFIGURATION:

WITH OR WITHOUT WEAPONS AND 600
GALLON TANKS ON STATIONS 2, 3, 4, 5, 6 AND 7
GEAR AND FLAPS DOWN
SLATS EXTENDED
WEAPONS BAY EMPTY
NORMAL FUEL DISTRIBUTION

FUEL GRADE: JP-4
ENGINES: TF30-P-7





F0000000-F072 B

Figure 6-5. (Sheet 1)

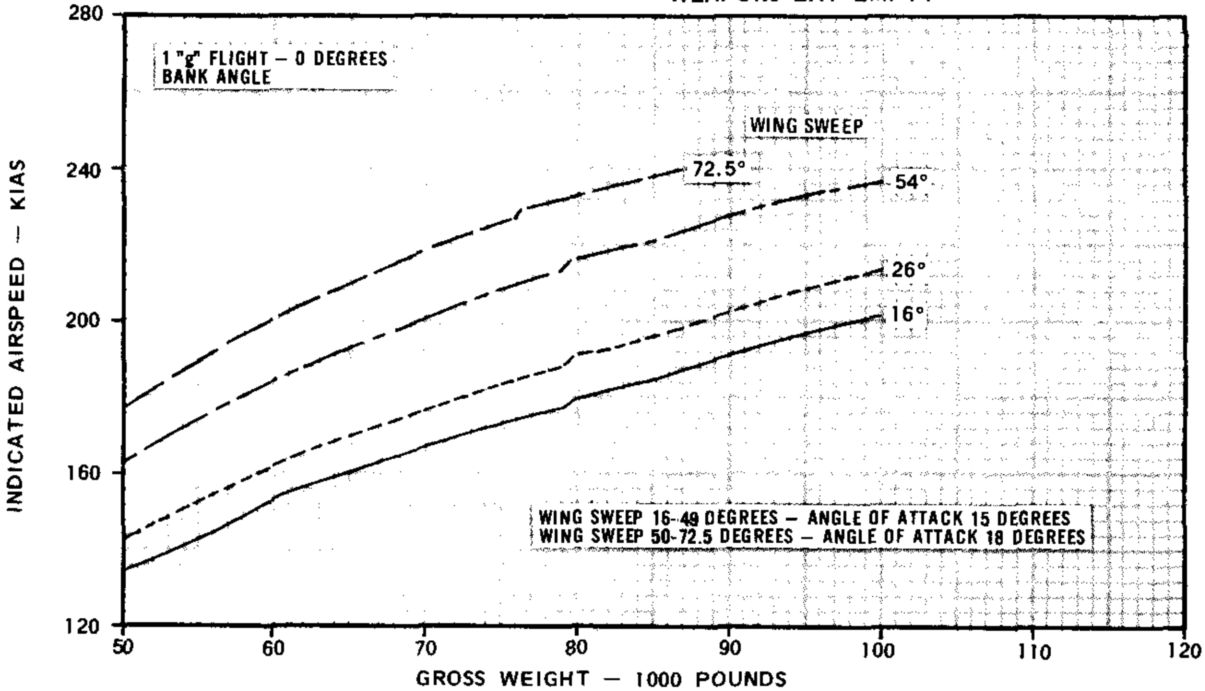
Minimum Airspeeds

CONFIGURATION:

DATA BASIS: ESTIMATED
DATE: 19 MAY 1972

GEAR UP AND FLAPS UP
SLATS RETRACTED

WITH OR WITHOUT WEAPONS
AND 600 GALLON TANKS
ON STATIONS 3, 4, 5 AND 6
WEAPONS BAY EMPTY



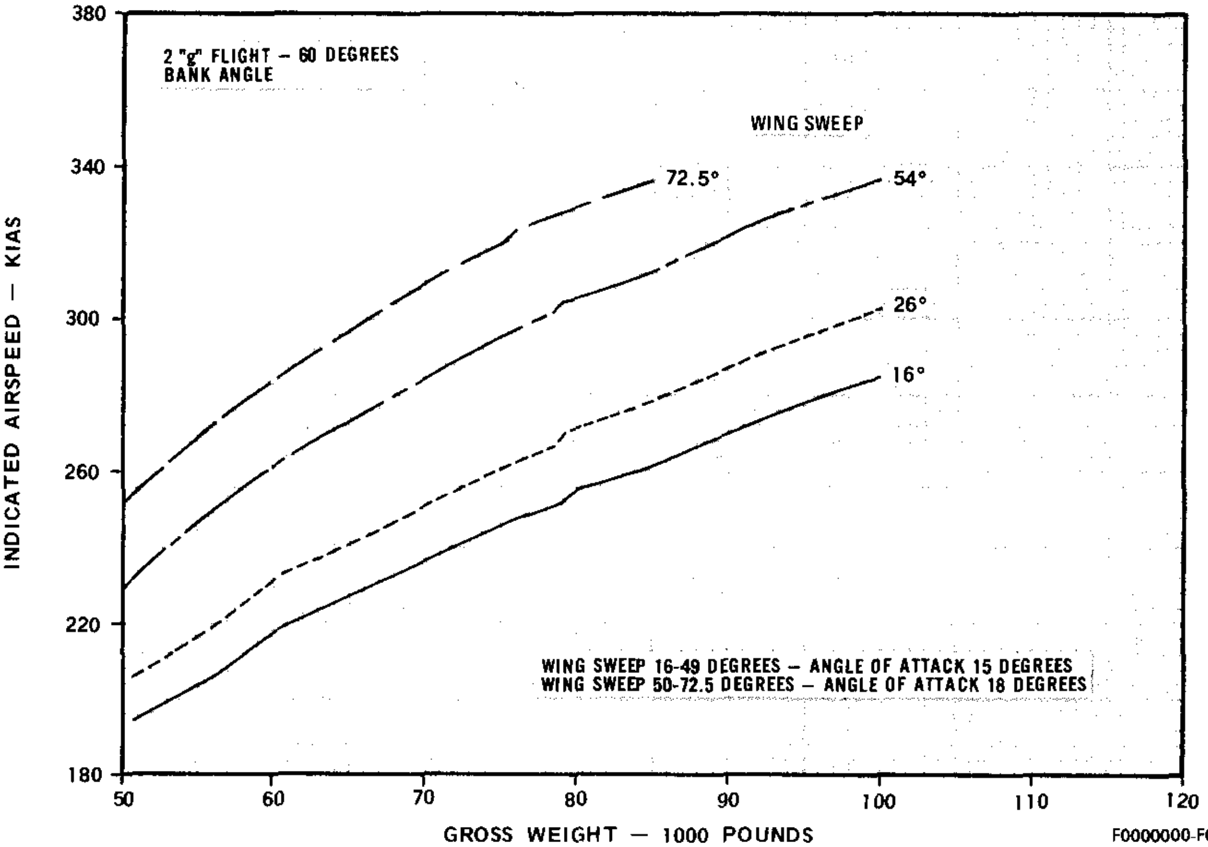


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Figure 6-5. (Sheet 2)

Effect of Thrust Changes.

Most of the time, aircraft are flown on the frontside of the curve where it takes more thrust to fly faster and less to fly slower. When thrust reductions are made on the frontside of the curve, the aircraft slows down until it reaches a new stabilized speed at which thrust required equals the new thrust selected. On the backside of the curve, however, this is not true. Thrust reductions on the backside of the curve are divergent; that is, once thrust is reduced, speed will begin to reduce and, unless a correction is made, never stabilize at a lower speed. The reason may be seen in figure 6-6. Choose a point on the backside of the curve, and imagine the aircraft flying there in 1 "g" stabilized conditions. If thrust is now reduced slightly, the aircraft will begin to slow down, but at the slower speed even more thrust is required, so it slows down even faster. The aircraft will continue to decelerate until control is lost, or until a correction is made.

Effect of Speed Changes.

A similar result can also be produced by a decrease in speed at constant thrust. If, for example, speed falls off slightly due to atmospheric disturbances (gust, turbulence, etc.) during flight on the frontside of the curve, airspeed will eventually rebuild and stabilize at its initial value. On the backside of the curve, thrust will be insufficient at the lower speed, and speed will continue to decrease until a correction is made or control is lost.

Effect of "g".

An understanding of the effect of "g" on thrust required may be obtained by referring to figure 6-6 and considering the following example. Curve A is for 1 "g" and Curve B is for 1.5 "g" flight.

Pick a point on Curve A and assume that the aircraft is flying there in 1 "g" level flight. Now assume that the aircraft rolls into a level 1.5 "g" turn; the thrust required is now determined by projecting vertically upward to Curve B. At lower airspeeds, the increase in thrust requirements can be very large (as shown by the longer arrows on the left side of the chart). Also, at any speed, increasing the "g" load can place the aircraft on the backside of the curve. At higher airspeeds, higher "g" loads are necessary to place the aircraft on the backside of the curve, but it is still possible.

Effect of Gross Weight.

The effect of gross weight upon thrust requirements is similar to the effect of "g," in that pulling 2 "g" is the same as doubling the weight of the aircraft. For a heavier aircraft, the backside of the curve extends to a higher airspeed; therefore, when flying a heavy aircraft, particular attention must be paid to angle of attack in order to avoid inadvertent flight on the backside of the curve.

Effect of Flaps and Slats.

Figure 6-6 shows three thrust required curves. Curve A is for the aircraft with flaps and slats retracted, Curve B is for the aircraft with flaps and slats extended, and Curve C is for the aircraft with slats only extended. Note that the slope of the backside of the curve is more gradual with flaps and slats extended or with slats only extended, hence, drag and angle-of-attack buildup will be easier to detect and control.

Figure 6-6 also shows that if extension of flaps and slats is delayed during decelerating flight, the clean aircraft will reach the steep backside of the power curve at a much higher airspeed than it would if flaps and slats were extended.

WARNING

It is most important to remember that any delay in selection of flaps and slats can be critical during decelerating flight.

Effect of Wing Sweep.

Figure 6-6 shows thrust required curves for 16, 26, 35, 50, and 72.5 degrees wing sweep. Note that although the slope is more gradual at wing sweeps aft of 35°, the backside of the thrust required curve extends to much higher airspeeds. An important effect of wing sweep is that if wings are inadvertently left aft of 26 degrees, flaps and slats cannot be extended. This may place the aircraft at a critical airspeed in the clean configuration, and unless immediate corrections are made, thrust required may exceed thrust available.

Flight Control System Effects.

In most aircraft, deceleration at constant "g" requires either nose-up trim or back pressure on the stick. This trim change or stick force change is an indication to the pilot that speed has been lost. In this aircraft during decelerating flight at constant "g," command augmentation will produce additional elevator deflection with no pilot input. As a result, in this aircraft, stick force and trim change are not available to tell the pilot that speed is being lost. The pilot must refer to his flight instruments, particularly during decelerating flight at lower airspeeds, and must control angle-of-attack to avoid inadvertent flight on the backside of the curve.

Thrust Versus Airspeed

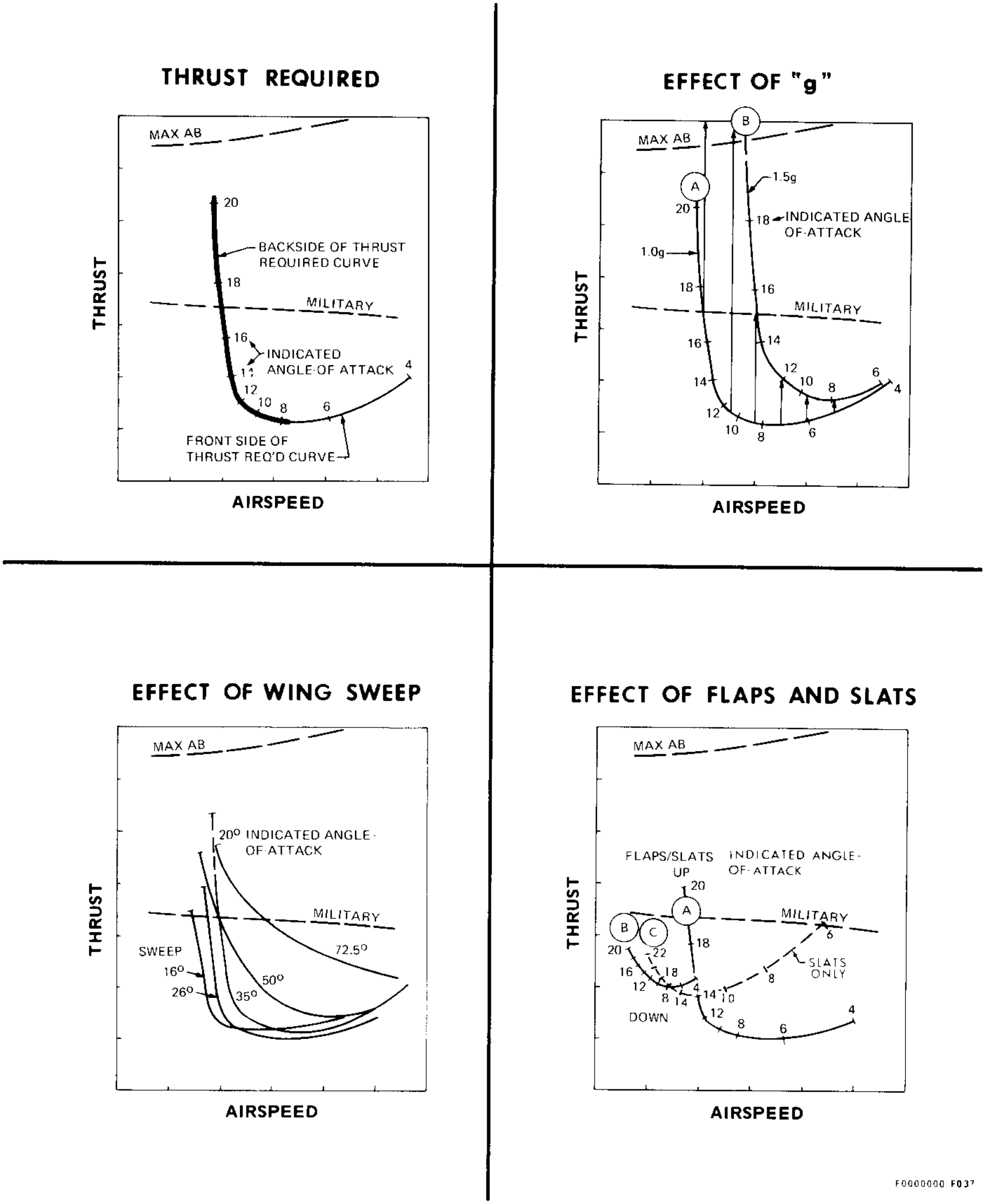


Figure 6-6.

Corrections.

There are four types of corrections that can be made to prevent loss of speed due to insufficient thrust on the backside of the curve:

1. Increase thrust.
2. Reduce "g."
3. Lower the nose to trade altitude for airspeed.
4. Change configuration.

It is important to realize that compensation for insufficient thrust must be made immediately or thrust required may quickly exceed maximum thrust available. If this happens, and if the configuration cannot be changed quickly by lowering flaps and slats, only two possible corrections remain: Reduce "g" or decrease altitude. If the aircraft is already at minimum "g" and altitude, no recovery is possible.

The key to avoiding inadvertent flight on the backside of the power curve is control of angle-of-attack. By controlling angle-of-attack, the pilot can compensate for variations in wing sweep, "g" loading and gross weight, and can readily maintain a safe margin.

LOW SPEED FLIGHT-FLAPS/SLATS RETRACTED.

Low speed flight with flaps and slats retracted involves a critical angle-of-attack buildup problem. In 1 "g" flight, wings level, 11 degrees indicated angle-of-attack can be maintained with moderate power requirements at 26 degree wing sweep. (True angle-of-attack in this speed range may be as much as 1.7 degrees greater than indicated). Actual angle-of-attack errors are as follows:

Mach	Angle-of-Attack Error (Degrees)	
	Flaps Up	Flaps Down
Less than 0.30	+1.7	0
0.40	+ .4	—1.3
0.45 to 1.25	0	—1.7

Note

Add error to indicated angle-of-attack to obtain true angle-of-attack. Interpolate between mach numbers.

A turn requiring a 30 degree bank will increase indicated angle-of-attack to 15 degrees or greater and require military thrust to maintain speed. Any delay in applying power, or additional flight path disturbance (gusts, additional bank angle, etc.) may result in the loss of several knots airspeed, and full military thrust will not be sufficient to maintain level flight. Maximum afterburner thrust may not be attainable before thrust requirements have reached and exceeded that thrust level (a loss of only 3 to 8 knots is sufficient to cause angle-of-attack to exceed 22 degrees), resulting in a rapid (2-3 seconds) and uncontrollable deceleration into a stall, resulting in a possible post-stall gyration or spin. Rapid rotation to a nosedown attitude can halt this deceleration, but will be extremely dangerous at low altitude. It is imperative that the recommended no flap-slat angle-of-attack for landing approach not be exceeded (11 degrees for wing sweeps 16-45 degrees and 12 degrees for wing sweeps greater than 45 degrees). Maneuvering at angle-of-attack in *excess of 10° should be avoided.*

RECOVERY FROM UNUSUAL ATTITUDES.

Unusual attitudes are considered to be those situations in which the pilot realizes that the aircraft is in an attitude/airspeed condition that he feels should be corrected so as to avoid even more unusual conditions from developing. In situations such as this, it is important that the corrective action which is taken not tend to aggravate the situation. For example, if in a nose-high attitude, airspeed is observed to be low, lateral control inputs should be minimized to avoid the possibility of spin entry. Therefore, airspeed is considered to be a primary factor in determining the proper corrective action to be taken. The following general techniques are recommended for use in recovery from unusual attitudes.

LOW AIRSPEED (BELOW 250 KIAS) — NOSE HIGH OR LOW.

- Center the stick laterally and neutralize the rudder.
- *Push forward on the stick to reduce angle-of-attack.* Attain zero "g's" if altitude permits.
- Advance throttles to MIL or beyond if necessary to obtain an increasing airspeed.
- Level the wings when angle-of-attack is below 15 degrees and airspeed is increasing above 250 KIAS.
- Complete the recovery to normal conditions.

HIGH AIRSPEED (250 KIAS OR GREATER) — NOSE HIGH.

- *Establish a bank angle of approximately 90 degrees* keeping the ball centered with rudder.
- Reduce "g's" to about zero.
- Use throttles to maintain a safe speed.
- When airspeed begins to increase, level the wings.
- Complete the recovery to normal conditions.

HIGH AIRSPEED (250 KIAS OR GREATER) – NOSE LOW.

- Level the wings.
- Place the throttles to IDLE. Speed brake may be extended if within airspeed/mach limits.
- Complete the recovery to normal conditions.

Note

Wing sweep position should not be changed until normal conditions have been attained.

STALL/LOSS OF CONTROL CHARACTERISTICS.

The aircraft obtains a large amount of lift from its fuselage and glove, particularly at high angles-of-attack. During the approach to stall, wing lift decreases rapidly while fuselage and glove lift continue to increase. As a result of this continuing lift, the aircraft does not exhibit the conventional "g" break associated with stall on most other aircraft. Since sufficient longitudinal control power exists at all wing sweeps to pull the aircraft up to angles of attack in excess of those where directional stability goes to zero (i.e., zero restoring moment to yaw disturbance), stall angle-of-attack is defined as the angle-of-attack at which directional divergence occurs.

WARNING

- Aircraft drag at high angle-of-attack may exceed total thrust available. This will result in a loss of airspeed, altitude, or "g" capability, and can lead to rapid loss of control unless the crew becomes aware of the situation and takes immediate corrective action. This is a particularly critical condition during 1 "g" flight at minimum altitude, where no corrective action may be possible.
- The pitch command augmentation feature of the flight control system will attempt to maintain the stick commanded level of pitch rate and "g" force independent of airspeed variations. During flight conditions where airspeed is decreasing, the horizontal stabilizer will be commanded to increase angle-of-attack, without additional pilot input. Under these conditions, unless the pilot is monitoring and controlling angle-of-attack, command augmentation can cause angle-of-attack to increase until control is lost.

STALL WARNING CHARACTERISTICS.

Test results have shown that no sudden, abrupt motions will occur to warn of stall. As angle-of-attack increases during a typical stall approach, the following stall warning characteristics may occur in the order shown.

1. Artificial Stall Warning System (after T.O. 1F-111-891). This system provides simultaneous actuation of the pedal shaker, a flashing red lamp and a steady tone. System operation is described in Section I.
2. Rudder Pedal Shaker (prior to T.O. 1F-111-891). Although the rudder pedal shaker will be activated, it has not proved to be an effective stall warning device. It may be masked by airframe vibration or buffet, and obviously requires that the pilot's feet be on the pedals.
3. Indicated Angle-of-Attack Will be Above Section V Limit. Stall is an angle-of-attack related event. Stalls can occur at a variety of airspeeds, "g" loadings, gross weights, wing sweeps, attitudes, thrust settings, external store configurations and flap/slat positions, but always occur as a result of excessive angle-of-attack. The aircraft cannot be stalled within angle-of-attack limits. Angle-of-attack indications are reliable up to 22 degrees. If angle-of-attack exceeds 25 degrees between mach 0.4 and 1.25, the CADC caution lamp and the master caution lamp will light.
4. A High Sink Rate Most Evident During 1 "g" Stalls. During flight test 1 "g" stall approaches at MIL thrust, sink rates of 3,000 to 6,000 feet per minute developed. Prestall sink rates were greater at aft wing sweeps. The sink rate may not be noticeable during maneuvering flight.
5. Precise Attitude Control Becomes Difficult. If the pilot is attempting to control attitude precisely, pilot control inputs increase in size and number just before 1 "g" level flight stalls. This will not be a useful stall warning cue during stall when the pilot is not attempting to control attitude precisely.
6. Wing Rock and Degraded Roll Control. A small amount of low amplitude, low frequency wing rock or wing drop may occur. Roll control effectiveness will rapidly degrade as stall angle-of-attack is reached. A continuous lateral stick input may be necessary just to keep from rolling or to continue a desired angle of bank. Roll damper saturation will be indicated by a large increase in lateral stick force.
7. Degraded Directional Stability. If the stall is approached slowly, the nose of the aircraft will gradually and smoothly begin to wander to the left or right. A gradual increase in side forces may be noticed. This will begin a few seconds prior to complete loss of control.

CAUTION

- There is no sudden loss of lift ("g" break) or change in stick force or position associated with aircraft stall. Pre-stall buffet may exist, but it is not a dependable stall warning since it varies for different configurations and its intensity may remain constant with increasing angle-of-attack. Buffet is very light and may not be noticed at aft wing sweeps.
- If the stall is approached rapidly, the natural aerodynamic cues will be effectively nonexistent. During hard maneuvering, angle-of-attack must be monitored and the artificial stall warning must be heeded.
- During maneuvering flight at high angles of attack within limits, large or abrupt control inputs should be avoided as they may cause unintentional angle-of-attack and sideslip excursions and contribute to loss of control.

In all cases and in all configurations, the immediate action which must be taken upon recognition of impending departure is to unload the aircraft and reduce angle-of-attack. Sufficient elevator power is available at all wing sweeps to effect recovery right up to the point of departure. There should be no effort made to counter uncommanded roll or yaw motions with roll control or rudder as these inputs may aggravate the situation. An immediate, forward stick displacement is the best means of lowering the angle-of-attack and recovering a controlled flight condition. Experience has shown that stalls can occur with little warning, and that the motion of the aircraft prior to, during, and following stall can be deceptively smooth and comfortable. The timing of recovery control application is critical. A momentary delay may mean complete loss of control and possibly loss of the aircraft. Stall avoidance is of particular importance, since the chances of recovery from a fully developed out-of-control condition are not good due to large altitude losses.

WARNING

If the preceding stall warning cues are not recognized, and stall is permitted to occur, the critical and immediate action required is to put the stick full forward and centered. Any delay can produce sustained out-of-control flight, from which the chances of recovery are not favorable.

DEPARTURE FROM CONTROLLED FLIGHT.

Departure from controlled flight is the event in the post-stall flight regime which precipitates entry into a post-stall gyration or spin. Departure is the brief aircraft motion which constitutes a transition from a controllable flight condition to complete loss-of-control. Departure is evidenced by a yaw divergence (nose slice) followed by an initial rolling motion in the direction of the yaw. After departure, the motion may continue in a rolling fashion for several rolls (probably the most prevalent form of post-stall gyration) or the aircraft may directly enter a spin. The most predominant indication of departure is a yaw acceleration. At low airspeeds, the departure will be smooth and fairly slow. For high airspeed entries, the departure could be more rapid.

WARNING

The critical and immediate action which must be taken when the pilot realizes that the aircraft has departed controlled flight is to reduce angle-of-attack. The out-of-control recovery procedures must be given time to be effective. Maintain these controls until type of maneuver is identified.

OUT-OF-CONTROL MOTIONS.

Note

The flight characteristics information beyond departure is based upon limited flight test data.

Following a departure from controlled flight, the aircraft may undergo any or all of the following different types of out-of-control motions: post-stall gyrations, upright or inverted spins, and inertia-coupled recovery rolls. Each out-of-control mode has certain characteristics which may enable the pilot to differentiate between them and to take the appropriate corrective action.

Post Stall Gyration.

A post-stall gyration is uncontrolled motion about one or more aircraft axes following departure. Although these motions differ from the motions occurring at departure, no additional control action is required. Maintain the "Out-of-Control Recovery Procedures," Section III. Although a majority of the gyration occurs at a post-stall angle-of-attack, lower angles may be

encountered intermittently in the course of the motion. The spin is differentiated from the post-stall gyration by the spin's predominant yaw rotation at a continuous post-stall angle-of-attack. In effect, the post-stall gyration will be any out-of-control event that is not specifically recognized as a spin or an inertia-coupled roll. The post-stall gyration will probably be of a rolling nature, although the motions may be somewhat random. Its characteristics are uncommanded motions (primarily roll and not yaw), an angle-of-attack indication generally above 25 degrees, and a low airspeed. Because the post-stall gyration will demonstrate primarily a rolling motion, it can easily be confused with the recovery roll (see "Recovery Characteristics", this section). The latter occurs near or within angle-of-attack limits and has its own recovery steps. It is re-emphasized that upon the first indication of loss of control, apply the "Out-of-Control Recovery Procedures," Section III.

Spins.

A spin is a continuous uncommanded yaw rotation at angles of attack above stall. The aircraft will enter spins from both upright and inverted conditions. Due to the large rate of altitude loss during an out-of-control situation (18,000 to 24,000 feet per minute), chances of recovery from a fully developed spin are marginal, particularly if the spin is entered at altitudes of 24,000 feet AGL or below. During a fully developed spin, flight control system hydraulic pressure may be lost if the rpm of both engines decreases below 35 percent.

Note

In all out-of-control conditions, one or both engines may stall. Stall will not be recognizable to the pilot as there will be no loud compressor stall. The engine(s) rpm will begin to decrease and TIT will increase due to insufficient airflow. Engine rpm will decrease to about 40 percent if the out-of-control situation persists.

Upright Spin.

Spin entry may occur directly following departure, or from a post-stall gyration. If the spin is entered directly from a high speed departure, the aircraft will initially follow a ballistic trajectory in which the yaw rotation appears to the pilot to be similar to a roll because of the alternating view of the ground and the sky. As the aircraft's forward velocity is reduced, the trajectory will become vertical and the yawing motion will become more evident. During a spin the ground will appear to sweep horizontally across the pilot's field of vision. Angle-of-attack will indicate between 22 and 25 degrees, but may occasionally show erroneous readings as low as 0 degrees during large nose-left sideslip conditions. Airspeed will indicate 140 KIAS or less. The motion will be smooth and constant without buffet. The turn needle will be pegged in the direction of the spin. Upon determining that the aircraft is in a spin, apply "Spin Recovery Procedure", Section III. Both full lateral control and forward stick are required for spin recovery. In order to obtain full lateral control deflection, it will be necessary to remove some of the forward stick used during the "Out-of-Control Recovery Procedure." This is because of the pitch-roll mixer limits and authority limits. Also, with the roll damper off, the lateral stick will have to be moved through the detent position to the mechanical stop to obtain full lateral surface deflection. While the aircraft is spinning, normal acceleration will remain relatively constant at approximately 1 "g". As recovery begins, however, "g" will begin to vary between increasing positive and negative values. This rougher, more oscillatory pitching motion of the aircraft should indicate to the crew that recovery is in progress. Shortly thereafter the aircraft may assume a steeper nose-down pitch attitude and the aircraft motion may become primarily rolling rather than yawing. As control is regained, the aircraft will finally respond to the forward stick input by unloading to zero or negative "g". Immediately neutralize rudder and aileron to avoid entering a spin in the opposite direction. Continue to apply forward stick as necessary to maintain approximately zero "g" and zero degrees angle-of-attack. This forward stick should not be removed until dive recovery airspeed (approximately 300 KIAS) is obtained. All large amplitude oscillations should have ceased by this time. Some uncommanded oscillations may still exist as dive recovery speed is reached; however dive recovery should be initiated even if such residual motions exist. Angle-of-attack should be monitored to insure that recovery has occurred. Note that low angle-of-attack alone is insufficient indication of recovery. Both angle-of-attack and airspeed must be checked. Aircraft oscillations may persist for several cycles after control is regained especially if dampers are off. During the recovery process, the aircraft will initially be in a nearly vertical attitude and external visual cues may be confusing. Continual monitoring of angle-of-attack and altitude is necessary. A smooth dive pullout should be commenced at approximately 300 KIAS observing angle-of-attack limits. If control of the aircraft has not been regained by 15,000 feet AGL, eject.

Inverted Spins.

An inverted spin will be very similar in nature to an upright spin except that the crew will be subjected to approximately a negative 1 "g" condition and the

angle-of-attack indicator will be pegged at —2 to —3 degrees. Although the inverted condition might generate confusion in identifying the direction of rotation, referring to the turn needle will always indicate the direction of rotation. Immediately upon determining that the aircraft has entered an inverted spin, apply inverted spin recovery procedures. Erroneous angle-of-attack information will be presented on the AMI while the aircraft angle-of-attack is below the probe limit (—2 to —3 degrees). Once the yaw rotation approaches zero and the nose falls through toward the vertical, rudder must be neutralized to avoid spin reversal.

Roll Coupling.

Coupling results when a disturbance about one aircraft axis causes a disturbance about another axis. An example of coupled motion is the disturbance produced by a rudder deflection which produces a combination of yawing and rolling motions. This interaction results from aerodynamic characteristics and is termed aerodynamic coupling. An example of uncoupled motion is the disturbance produced by an elevator deflection during level flight. A pitching motion occurs without disturbance in yaw or roll. A separate type of coupling results from the inertia characteristics of the aircraft. The inertia characteristics of the complete aircraft can be divided into the roll, yaw and pitch inertia, and each inertia is a measure of the resistance to rolling, yawing or pitching acceleration of the aircraft. The aircraft has a roll inertia which is quite small in comparison to the pitch and yaw inertia, that is, its resistance to roll is low. Inertia coupling can be illustrated by considering the mass of the aircraft to be concentrated in two elements, one representing the mass ahead of the cg and one representing the mass behind the cg. If the aircraft rolls about an axis which passes through these two mass concentrations (inertia axis) no inertia coupling would result from the following motion. If the roll axis is inclined with respect to the inertia axis, rotation about the roll axis will produce centrifugal forces and cause either a yawing or a pitching moment. This is inertia coupling. As a result of aerodynamic and inertia coupling, rolling motions can produce a great variety of longitudinal and lateral-directional forces and moments. All aircraft exhibit varying degrees of aerodynamic inertia coupling. Roll coupling causes no problem if the moments are easily counteracted by the aerodynamic restoring moments. Under certain conditions this aircraft, like most fuselage heavy aircraft (most of the mass concentrated along the longitudinal axis), can be forced into roll coupling. During rolling maneuvers the combination of forward stick and lateral stick in the direction of the roll can produce an uncommanded roll rate increase. Roll rates of up to 200 degrees per second may occur and be sustained. To recover, neutralize controls. Roll rate should begin to decrease immediately. Angle-of-attack may tend to increase as roll rate decreases, and should be controlled by using forward stick as required. During a sustained roll-coupled condition, angle-of-attack will usually be below 20 degrees, and airspeed will usually be between 200 and 350 KIAS. While a spin will appear to be primarily a yawing motion, roll coupling will be similar to a high roll rate aileron roll. To recover, neutralize controls and wait for the high roll rate to subside. Roll rate should begin to decrease immediately, and although uncommanded rolling will continue for 1 or 2 turns, recovery should be complete within 5 to 10 seconds. If uncommanded roll rate has not subsided within 5 to 10 seconds, rudder should be applied opposite the roll direction.

RECOVERY CHARACTERISTICS.

Recovery is defined as the transition from out-of-control conditions to controlled flight. Stall recovery, post-stall gyration recovery, spin recovery and recovery rolls will be discussed separately.

Stall Recovery.

If recovery controls are applied immediately as stall occurs, uncommanded yawing and rolling motions will stop and control will be restored. If the stall is entered from a high rate condition, control will probably be lost. Timing is important. A one-second delay in applying recovery controls may make the difference between immediate recovery and sustained uncontrolled flight. The key cockpit indications of stall recovery are angle-of-attack below 15 degrees and decreasing, and airspeed above 200 KIAS and steadily increasing. When recovery is assured, forward stick deflection may be reduced. Gradual and careful application of back stick may then be used to recover to level flight. Angle-of-attack must be closely monitored during pullout following stall recovery, as it would be easy to reenter the stall.

Post-Stall Gyration Recovery.

Recovery from a post-stall gyration may be recognized by angle-of-attack below 15 degrees and decreasing, and airspeed above 200 KIAS and increasing. In addition, the aircraft will assume a steeper nose-down pitch attitude, and will unload to zero or negative "g". When recovery is assured, gradually and carefully reduce forward stick deflection and, as airspeed continues to increase, commence a recovery to level flight, controlling angle-of-attack within limits.

Spin Recovery.

The key cockpit indications of spin recovery are angle-of-attack below 15 degrees and decreasing, and air-

speed above 200 KIAS and steadily increasing. There are also several physical cues which will aid the pilot in correctly assessing recovery from a spin. These include the following:

1. Rougher, more oscillatory motion of the aircraft as yaw rate decreases.
2. Steeper nose-down attitude.
3. Unloading to zero or negative "g" (if the spin is inverted, unloading to zero or positive "g").
4. Normal aircraft response to flight control inputs is regained. Aircraft oscillations may persist briefly after recovery has occurred, however, a cross-check of angle-of-attack and airspeed will confirm that these are temporary recovery oscillations and not out-of-control motions. No attempt to oppose these motions is necessary or should be made. Continue to apply forward stick as necessary to maintain approximately zero "g" and zero degrees angle-of-attack. This forward stick should not be removed until dive recovery airspeed (approximately 300 KIAS) is obtained. All large amplitude oscillations should have ceased by this time. Some uncommanded oscillations may still exist as dive recovery speed is reached; however, dive recovery should be initiated even if such residual motions exist.

Recovery Rolls.

During the recovery phase of a post-stall gyration or spin, the aircraft will experience an uncommanded roll or series of rolls near or below the stall angle-of-attack. These rolling motions could be caused by a control input or roll coupling, and serve as a further indication that the aircraft has recovered. Airspeed will be steadily increasing above 200 knots during these rolls, and angle-of-attack may increase to 15 to 20 degrees. Having verified that the aircraft is not spinning, neutralize roll control and use forward stick as necessary to keep angle-of-attack within limits. As uncommanded rolls stop and airspeed continues to build, the aircraft can be maneuvered to the proper attitude for dive pullout.

ALTITUDE LOSS AND DIVE PULLOUT.

Altitude loss during out-of-control conditions will depend on entry conditions (airspeed, altitude and vertical speed), configuration (gross weight, wing sweep and store loading), type of motion encountered (stall, post-stall gyration, roll coupling or spin), duration of out-of-control flight and pilot technique. If the aircraft is stalled from 1 "g" level flight and recovered without entry into a post-stall gyration or spin, a minimum of 3,000 feet altitude may be required to recover to level flight at the forward wing sweeps. At aft wing sweeps, the altitude lost during recovery to level flight may be doubled. To minimize altitude loss, the wings, if aft of 45 degrees, should be swept forward during dive recovery. If the stall occurs during high speed maneuvering flight, altitude requirements for recovery may be reduced, particularly if the aircraft was in level flight or climbing when the stall occurred. Altitude loss during a post-stall gyration and recovery can vary from 6,000 to 10,000 feet or more, depending upon entry conditions, configuration and maneuver duration. If a spin is encountered, altitude will be lost at the rate of 18,000 to 24,000 feet per minute. During the time required for recovery, a substantial amount of altitude will be lost (a minimum of 24,000 feet). Chances of recovery to level flight for a fully developed spin are therefore marginal, and become increasingly poor for lower altitude entries. Recovery capability will be marginal for any departure from controlled flight occurring below 6,000 feet AGL, for a post-stall gyration entered from below 10,000 feet AGL and for a spin entered from any altitude, particularly below 24,000 feet AGL. It is not recommended that external stores be jettisoned during an out-of-control situation because of a possible collision of aircraft and stores. Stores may be jettisoned during dive pullout if altitude is critical. Angle-of-attack limits must be observed during recovery to level flight. Dive recovery information can be obtained from the "Dive Recovery" paragraph in this section. During dive recovery pullouts, the flight control system and drag characteristics can easily contribute to an overrotation and lead to another out-of-control condition. The dive pullout should be conducted at no more than 15 degrees angle of attack. The wings, if aft of 45 degrees, should be swept forward to minimize altitude loss.

FLIGHT WITH EXTERNAL STORES.

The most predominant effects of external store loadings, other than performance effects, are the increased weight, inertia and aircraft sensitivity at high subsonic mach numbers (mach greater than 0.80). Abrupt control inputs should be avoided to preclude exceeding structural limitations associated with the various loadings. High roll rates are attainable when full normal lateral stick displacement is used for rolling maneuvers. This is true even with heavy loadings of wing/pylon mounted stores. The use of full normal lateral stick for rolls can produce roll rates in excess of the maximum allowable roll rates which are stated herein for many external store loadings. It is difficult to define an operating procedure that will prevent exceeding the maximum allowable roll rates with external stores installed. These allowable rates are considerably lower than those produced by lateral stick displacement to the force detent position (2.4 inches). The following comments are offered as a guide. Avoid using abrupt lateral stick inputs as a routine flying technique with external

stores installed. Abrupt stick input tends to cause high roll acceleration and roll rate. A recommended technique is to pressure the stick to a lateral displacement rather than a forceful displacement. An alternate is to limit lateral stick displacement to ½ that required at the force detent position (1.2 inches). This amount of lateral stick will produce roll rates approximately 50 to 70 degrees per second depending upon the store loading and wing sweep angle. Flight tests have shown that this "½ stick" displacement, abruptly applied (in about 1/10 second), results in 50 to 70 degree per second roll rates in as little as 60 degrees of bank angle change. Slower stick input to the same displacement allows larger changes in bank angle before the 50 to 70 degree per second roll rate is attained. This 50 to 70 degree per second roll rate is equal to or less than the roll rate limits applicable to most store loadings. It is noted that some store loadings and speed ranges allow clean aircraft roll rates obtainable with detent force displacement of the stick. Weapon separation has very little effect on aircraft response at weapon release. In most cases, the incremental normal acceleration has been less than 0.5 "g". Maximum roll and sideslip response experienced to date has been less than 5.0 degrees of roll and 2.0 degrees of sideslip. During drops conducted with retarded weapons, M-117R and MK-82S, slight aircraft pitching motions have been experienced as the weapons pass under the aircraft horizontal stabilizer. This phenomena is due to the pressure distribution change on the horizontal stabilizer caused by the opening of the retard fins under the stabilizer. Although this slight pitching motion poses no flight safety problem, it is a phenomena of which the pilot should be aware. As external stores are released, an asymmetrical store loading requiring more lateral trim than available may be encountered. If such a condition occurs use rudder trim as necessary. For flight limitations with asymmetric stores refer to "Stores Limitations," Section V.

FLIGHT WITH SPEEDBRAKE EXTENDED.

Extension of the speed brake will result in an aircraft noseup trim change. In the speed range (mach 0.80 or less) where the elevator angle for trim with the brake deflected does not exceed four degrees down (series trim limit), the flight control system will retrim the aircraft for the pilot. In the speed range (mach 0.80 to 1.0) where the elevator angle for trim is greater than four degrees down, the pilot will have to augment the series trim with the stick since the series trim is at its authority limit. Extension of the speed brake will also result in aircraft buffet during speed brake extended operations. Refer to Section V for operating limitations for speed brake extension.

DETERMINATION OF AFT ALLOWABLE CENTER-OF-GRAVITY POSITION.

The aft allowable center-of-gravity positions presented herein are given to allow calculation of and verification of the minimum fuel values presented under "Center-of-Gravity Limitations," in Section V. In order to calculate the minimum fuel loadings presented, the user must not only determine the aft allowable center-of-gravity position, but must also have access to the aircraft weight and balance handbook, T.O. 1-1B-40. Figure 6-7 is provided to determine the aft allowable center-of-gravity position for the basic aircraft and the store loadings authorized for carriage and release.

This figure contains a longitudinal section for low and high speeds, a directional section for high speeds, and a stability increment section. The longitudinal section is applicable only to the aircraft with no external stores (basic configuration), and the directional section is applicable to all configurations authorized for supersonic flight. The stability increment section is provided to determine the aft allowable longitudinal center-of-gravity position for flap changes and external store loadings. The aft allowable center-of-gravity positions are presented under the following considerations:

a. The longitudinal allowable positions are set to maintain at least one percent static margin.

b. The directional allowable positions are set to provide a minimum safe level of directional stability.

Example: Determine the aft allowable center-of-gravity position for store loading, wing sweep, and airspeed for specific phases of flight with B43 weapons loaded.

Given: Stations 4 and 5: B43 weapons for each of the following:

a. Takeoff: Flaps and gear down, 16 degree wing sweep, auxiliary flap extended, 25 degrees flaps.

b. Low Speed: Flaps and gear up, 16 degree wing, slats extended.

c. Low Speed: Flaps and gear up, 26 degree wing, clean aircraft, speed less than mach 0.6.

d. High Speed: 26 degree wing sweep, speed greater than mach 0.7.

e. High Speed: 72.5 degree wing sweep, mach 2.2.

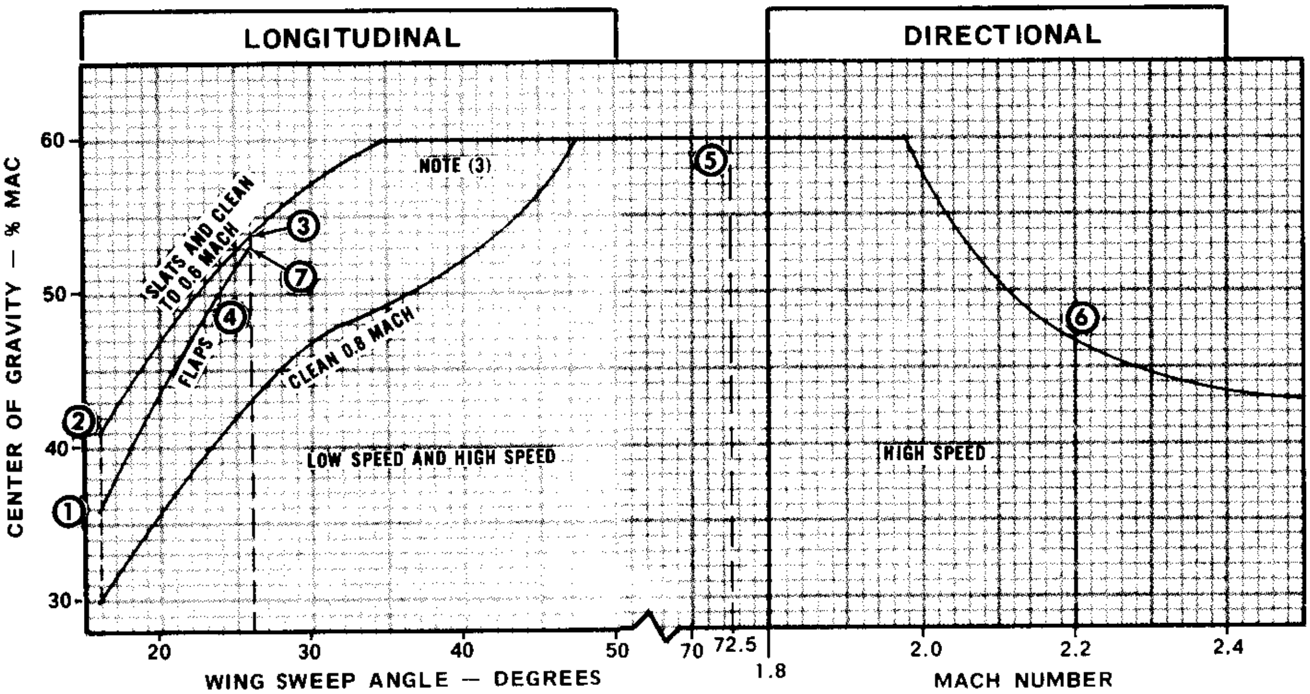
f. Landing: Flaps and gear down, 26 degree wing sweep, full flaps.

Find: Aft allowable center-of-gravity positions for the given conditions

Aft Allowable Center of Gravity Positions

DATE: 25 MAY 1973

BASIC CONFIGURATION:
NO EXTERNAL STORES
NO AUXILIARY FLAPS



LONGITUDINAL STABILITY INCREMENTS

PYLON STATIONS			STABILITY INCREMENTS (1)			
4 and 5	3 and 6	2 and 7	Full Flaps (2)	25 Deg. Flaps (2)	15 Deg. Flaps	Slats & Clean ★
None	None	None	0	−1	0	0
B43, 57, 61, SRAM	None	None	−1	−2	−1	−2.5
B43, 57, 61, SRAM	B43, 57, 61, SRAM	None	−2	−2	−1	−3.5
B43, 57, 61, SRAM	Tank	None	−2.5	−2.5	−1.5	−5
B43, 57, 61, SRAM	B43, 57, 61, SRAM	Tank	−3	−3	−2	−5
B43, 57, 61, SRAM	Tank	Tank	−3.5	−3.5	−2.5	−7
Tank	None	None	−2.5	−2.5	−1.5	−4
Tank	Tank	None	−3.5	−3.5	−2.5	−7
Tank	Tank	Tank	−4	−4	−3	−8.5
None	Tank	None	−2	−2	−1	−3
None	Tank	Tank	−3	−3	−2	−6.5

NOTES:

(1) For given store loading, add the stability increments to the basic allowable C.G. position.

(2) Subtract a stability increment of 2 for all store loadings at 16 degrees wing sweep with 23 degrees or more flap deflection for extension of aux flap.

(3) Interpolation between 0.6 and 0.8 mach is permissible.

(4) For symmetric pairs of weapons pylons with no weapons attached, use stability increments for no stores at those pylon stations.

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Figure 6-7.

First, find the aft allowable center-of-gravity position for the basic configuration and then obtain the required increments from the stability increment section. Follow the example lines on Figure 6-7 to determine the following:

	Aft Allowable Position
a. Takeoff, 16 degree wing sweep Basic, 36.0 1 , 2 B43's with 25 degree flaps, —2; auxiliary flap, —2.	32.0%
b. Low speed, flaps and gear up, 16 degree wing, slats extended: Basic, 40.5 2 , 2 B43's, —2.5.	38%
c. Low speed, flaps and gear up, 26 degree wing, speed less than mach 0.6: Basic, 54.0 3 , 2 B43's, —2.5.	51.5%
d. High speed, 26 degree wing, speed greater than mach 0.7: Basic, 48.5 4 , 2 B43's, —2.5. (Determine basic by linear interpolation between 0.6 and 0.8 mach)	46.0%
e. High speed, 72.5 degree wing, mach 2.2:	
(1) Longitudinal	60% 5
(2) Directional	47% 6

Note

The aft allowable position for directional stability is further forward than that for longitudinal stability; therefore, it would determine the aft allowable center-of-gravity position for flight in this regime.

f. Landing, 26 degree wing sweep: Basic, 53.0 7 , 2 B43's, —1	52.0%

If external stores are jettisoned, the stability increment section of figure 6-7 should be used to determine the aft allowable center-of-gravity positions for the symmetric pairs remaining. After determining the aft allowable center-of-gravity position, either longitudinal or directional, refer to "Center-of-Gravity Envelope", this Section, to determine the gross weight ranges within which the aircraft should be operated to remain within the center-of-gravity limits.

Note

When landing with the weapons bay unloaded or lightly loaded in conjunction with certain external store loadings, sufficient fuel must be retained in the forward tank to maintain the center-of-gravity within the aft center-of-gravity limits.

CENTER-OF-GRAVITY ENVELOPE.

Figure 6-8 presents a typical center-of-gravity envelope for the aircraft with and without internal stores. Because of the variance in basic weight and center-of-gravity conditions between aircraft, the weight and balance handbook, T.O. 1-1B-40, must be used to determine the actual weight and balance conditions of a specific aircraft. Fuel sequencing (pounds used) for an 8200 pound differential between the forward and aft tanks is identical regardless of stores loading if auto engine feed is selected.

WING SWEEP POSITION FOR LANDING.

Figure 6-9 may be used to determine the wing sweep setting required to remain within center-of-gravity limits for landing. Center-of-gravity lines are shown for two groupings of external store loadings: (1) no external stores, two tanks (stations 4 and 5 or 3 and 6), weapons with or without two or four tanks (weapons on stations 4 and 5 with tanks on stations 2 and 7 and/or 3 and 6, or weapons on stations 3, 4, 5, and 6 with or without tanks on stations 2 and 7); and (2) four tanks (stations 2, 3, 6, and 7 or stations 3, 4, 5, and 6), and six tanks (stations 2, 3, 4, 5, 6, and 7). Forward center-of-gravity lines are shown for flap settings of 25 degrees and full flaps and are applicable regardless of external store configuration. These charts assume normal fuel sequence (auto engine feed), and will not be used in conjunction with abnormal fuel distributions. The chart allows the crew member to compute and select a wing sweep margin that will assure that the aircraft is within center-of-gravity limits for landing. The aft and forward wing sweeps computed will correspond with the following elevator position indications (EPI) and should be used in conjunction with these EPI readings to assure that the aircraft is within center-of-gravity limits for landing.

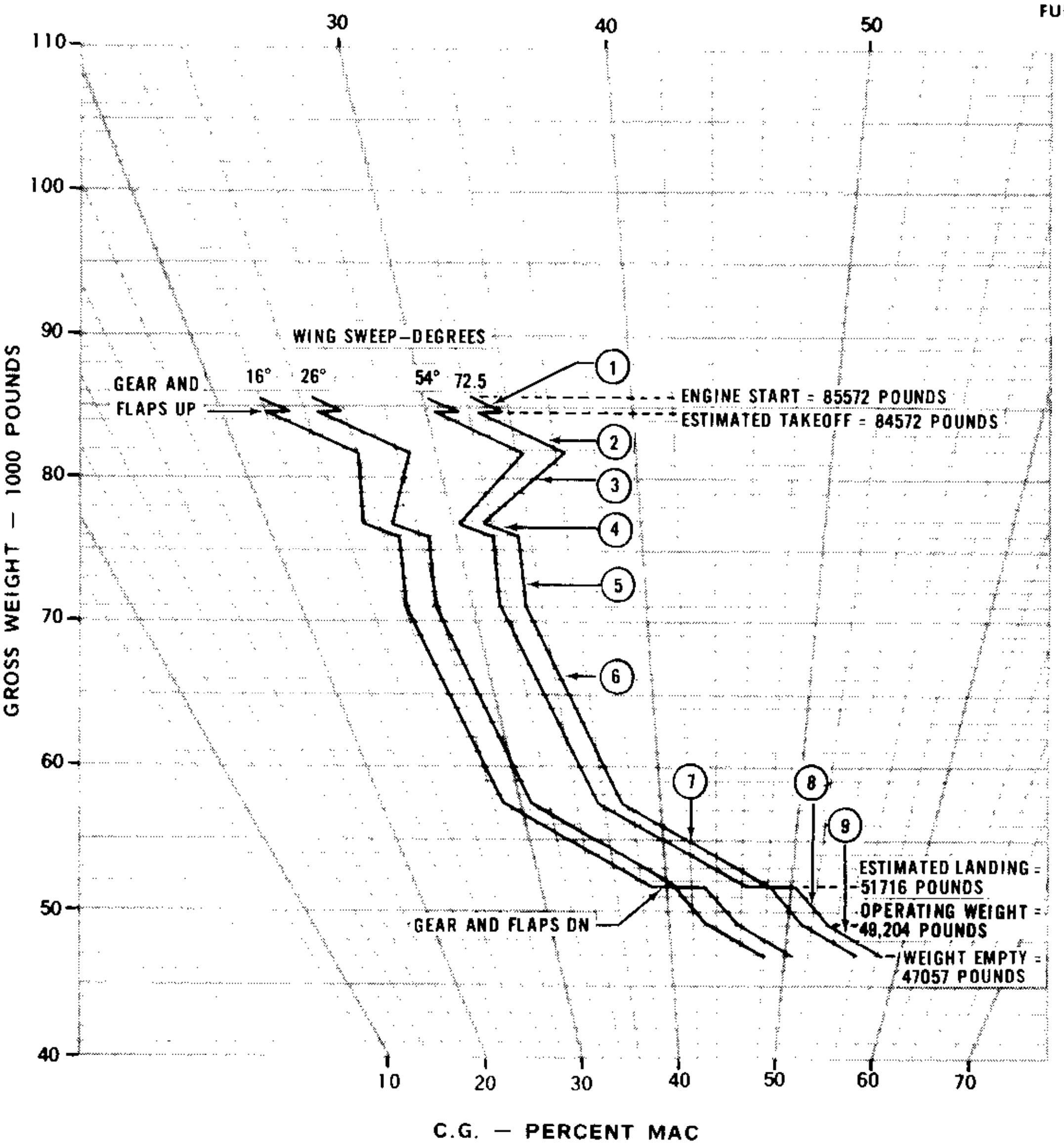
	Forward C.G. EPI	AFT C.G. EPI
(1) 26° wing sweep	12° T.E. Up	6° T.E. Up
(2) 16° wing sweep (no aux flaps)	15° T.E. Up	8° T.E. Up
(3) 16° wing sweep (aux flaps)	12° T.E. Up	6° T.E. Up

All computations are based upon aircraft angle-of-attack of 10. Enter the chart with the predicted landing fuel and project vertically to the aft center-of-gravity line for the appropriate aircraft configuration, then horizontally to read wing sweep. This is the most forward allowable wing sweep for landing. Continue the vertical projection to the forward center-of-gravity line corresponding to the desired flap setting, then horizontally to wing sweep. This is the most aft

Center-of-Gravity Envelope

CONFIGURATION:

CLEAN W/WEAPONS BAY FUEL TANKS.



FUEL SEQUENCE (8200 POUND DIFFERENTIAL)	
TANK	POUNDS FUEL USED
1 WEAPONS BAY	1000 POUNDS (TAXI AND TAKEOFF)
2 WEAPONS BAY	2800 (WEAPONS BAY TANKS EMPTY)
3 WING	5060 (WINGS EMPTY)
4 FORWARD	800 (8200 LB. △ FWD. & AFT)
5 FORWARD & AFT	4800 (A2 EMPTY)
6 FORWARD & AFT	13708 (A1 EMPTY)
7 FORWARD	5688 (F1 & F2 EMPTY)
8 FORWARD (RESERVOIR)	2512 (RESERVOIR FUEL EMPTY)

TOTAL FUEL USED	36368 POUNDS
9 CREW, OIL, & OPERATING WEIGHT MISCELLANEOUS	

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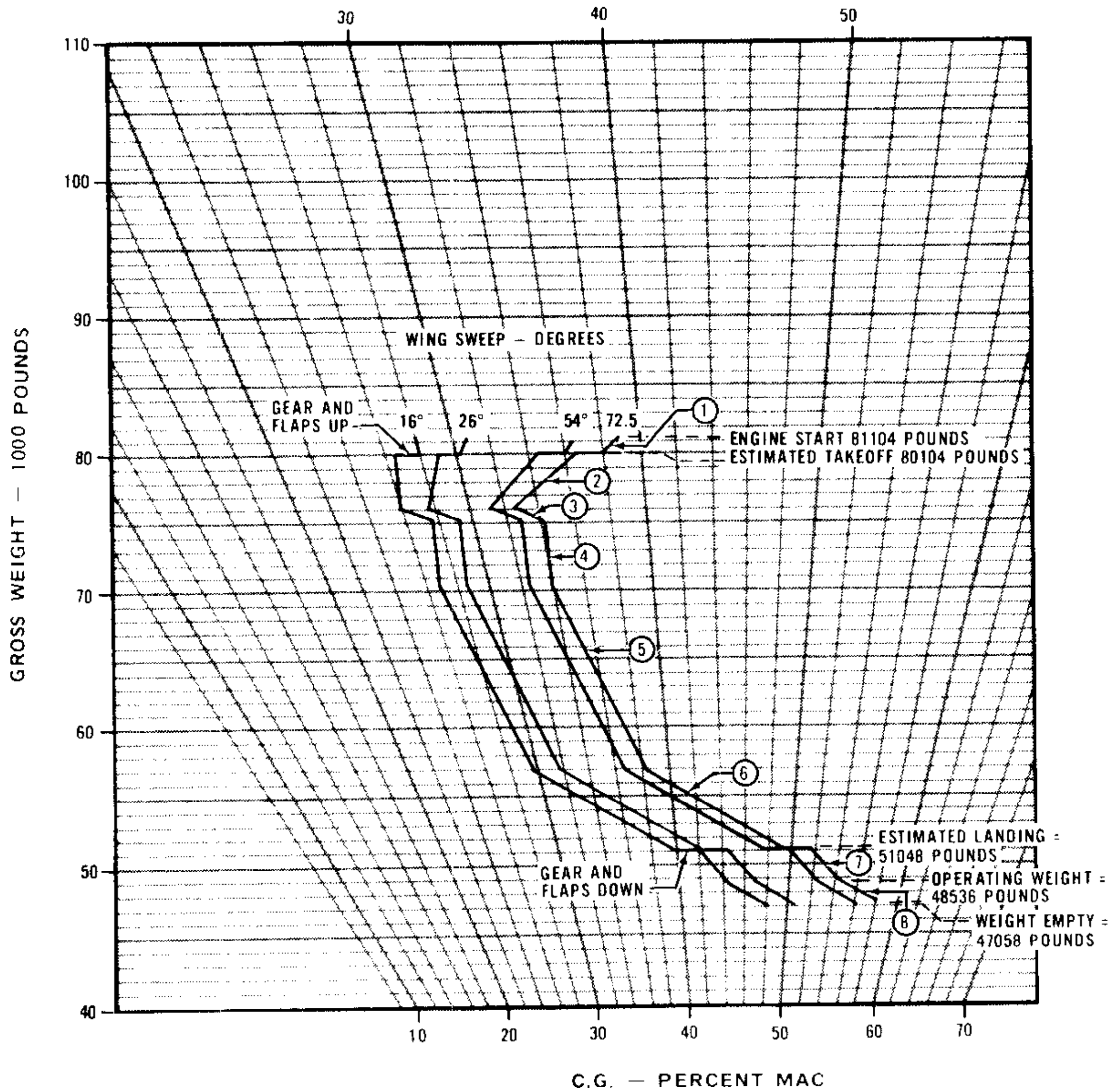
Figure 6-8. (Sheet 1)

Center-of-Gravity Envelope

CONFIGURATION:
CLEAN AIRPLANE



FUEL SEQUENCE (8200 POUND DIFFERENTIAL)	
TANK	**POUNDS FUEL USED**
1 WING	1000 POUNDS (TAXI & TAKEOFF)
2 WING	4060 (WINGS EMPTY)
3 FORWARD	800 (8200 Δ FWD & AFT)
4 FORWARD & AFT	4800 (A2 EMPTY)
5 FORWARD & AFT	13708 (A1 EMPTY)
6 FORWARD	5688 (F1 & F2 EMPTY)
7 FORWARD (RESERVOIR)	2512 (RESERVOIR EMPTY)

TOTAL FUEL USED	32568 POUNDS
8 CREW, OIL & OPERATING WEIGHT MISCELLANEOUS	

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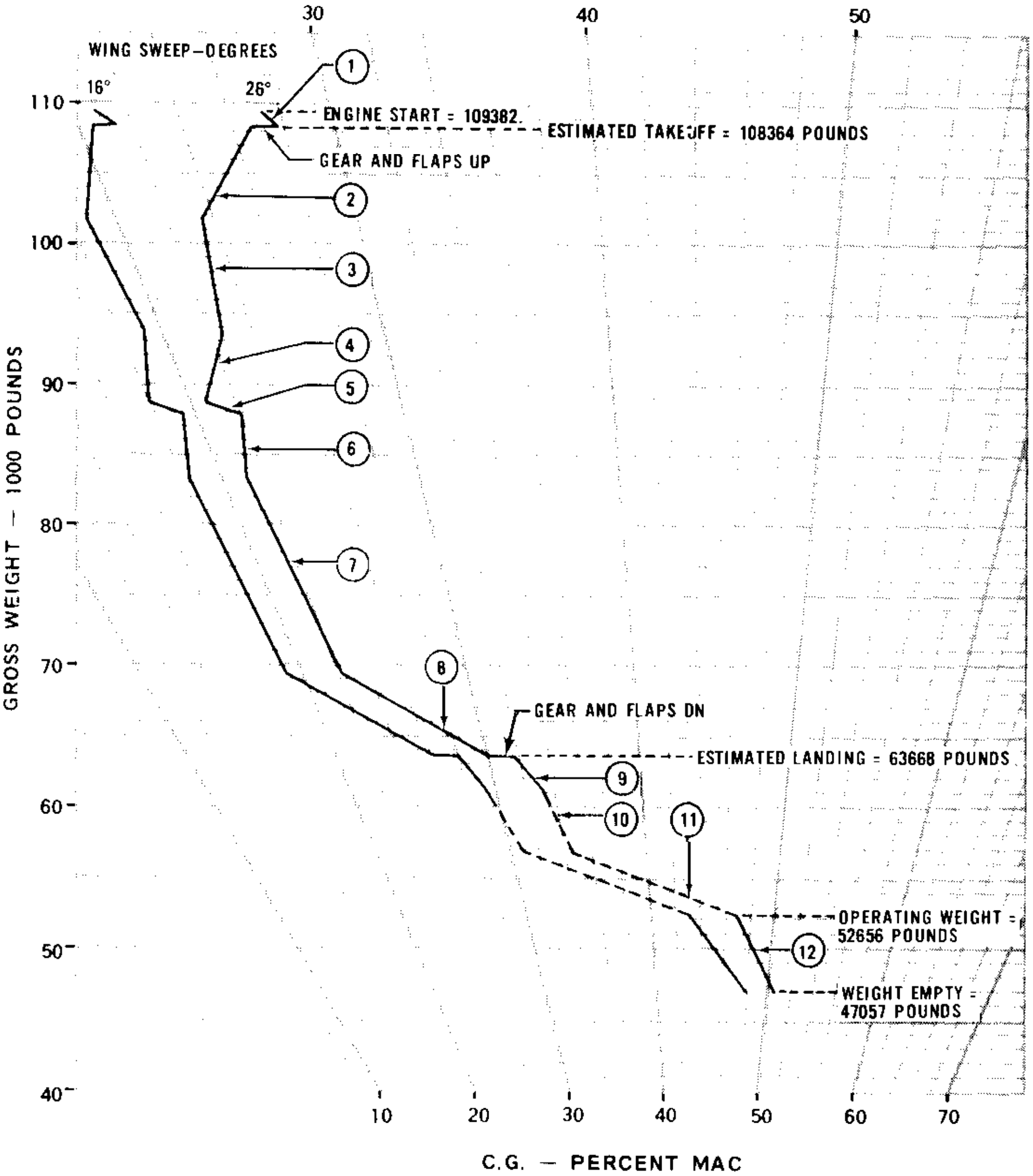
Figure 6-8. (Sheet 2)

Center-of-Gravity Envelope

CONFIGURATION:
2 B43'S - (STATIONS 4 & 5).
2 B43'S - (WEAPONS BAY).
4 EXTERNAL FUEL TANKS - (STATIONS 2, 3, 6 & 7).



FUEL SEQUENCE (8200 POUND DIFFERENTIAL)	
TANK	POUNDS FUEL USED
1 INBD. FIXED PYLON	1018 POUNDS (TAXI & TAKEOFF)
2 INBD. FIXED PYLON	6824 (FIXED PYLONS TANKS EMPTY)
3 OUTBD. PIVOT PYLON	716 (PIVOT PYLONS TANKS EMPTY)
4 WING	5060 (WING EMPTY)
5 FORWARD	800 (8200 LB Δ FWD. & AFT)
6 FORWARD & AFT	4800 (A2 EMPTY)
7 FORWARD & AFT	13706 (A1 EMPTY)
8 FORWARD	5688 (P1 & F2 EMPTY)
9 FORWARD (RESERVOIR)	2512 (RESERVOIR)

TOTAL FUEL USED	48226 POUNDS

10 WING PAYLOAD (2 B43'S ON INBOARD PIVOTING PYLONS)
11 WEAPONS BAY PAYLOAD (2 B43'S)
12 CREW, OIL, PYLONS & OPERATING WEIGHT MISCELLANEOUS

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Figure 6-8. (Sheet 3)

Wing Sweep for Landing

DATA BASIS: ESTIMATED
DATE: 25 MAY 1973

FUEL GRADE: JP-4
ENGINES: TF30-P-7

CONSIDERATIONS:

- FLAPS AND GEAR EXTENDED
- AUTO FUEL SEQUENCE
- OPERATING CG 46.2% MAC
- AFT LIMITS:
  - 26° SWEEP—4° EPI
  - 16° SWEEP—4° EPI WITH AUX FLAP
    6° EPI NO AUX FLAP
- FORWARD LIMITS.
  - 26° SWEEP—12° EPI
  - 16° SWEEP—12° EPI WITH AUX FLAP
    15° EPI NO AUX FLAP
- CHECK EPI AT 10° ANGLE-OF-ATTACK
- FOR WEAPONS BAY STORES:
  - —WITH WEAPONS ON PYLONS, SWEEP WINGS FORWARD 2° FOR EACH 1000 POUNDS OF STORES IN THE BAY.
  - —WHEN CARRYING ONLY EXTERNAL TANKS OR FOR CLEAN AIRCRAFT (NO EXTERNAL STORES), SWEEP THE WINGS FORWARD 1.5° FOR EACH 1000 POUNDS OF STORES IN THE BAY.

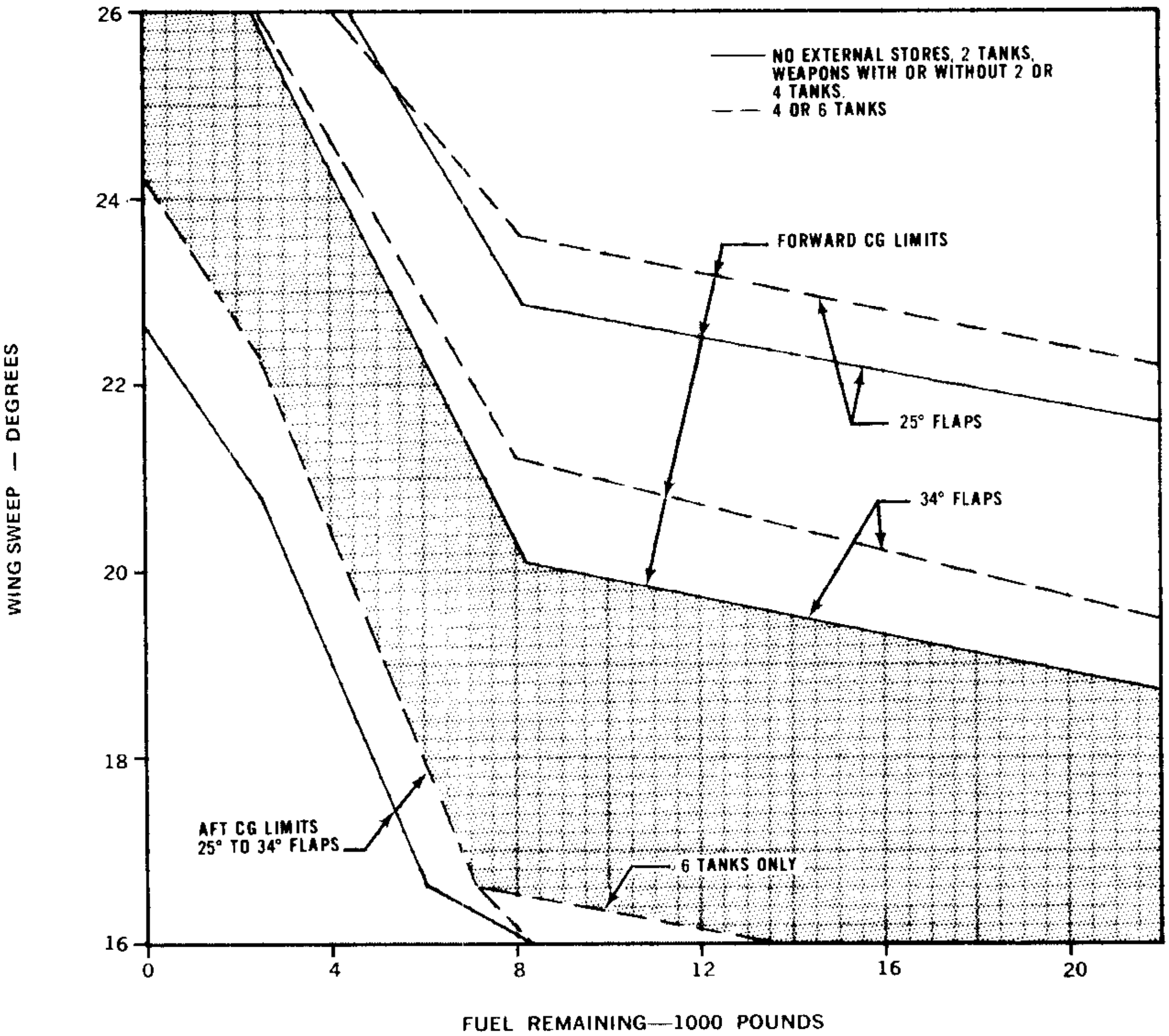

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Figure 6-9.

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allowable wing sweep for landing. Selecting a wing sweep between these two values will provide an elevator trailing edge deflection within center-of-gravity limits for landing. Figure 6-5 is not directly applicable to those configurations which include weapons bay stores. However, as a rule of thumb, for bay stores when carrying external weapons with or without tanks subtract 2.0 degrees wing sweep per 1000 pounds of weapon bay stores from the forward and aft center-of-gravity line selected. As a rule of thumb, when carrying only external tanks or for the clean aircraft (no external stores), sweep the wings forward 1.5 degrees for each 1000 pounds of weapon bay stores. Use the corrected wing sweeps to compute the applicable wing sweep margin with bay stores. If the forward center-of-gravity line corresponding to full flaps is being utilized it is possible with heavier weapon bay store loadings to shift the forward line to a value less than 16° wing sweep. In this event, the landing must be made either with 25° of flaps and 16° wing sweep or delayed until fuel weight reduction will allow a landing with full flaps. Figure 6-5 also provides an indication as to the action required if the aircraft is not within c.g. limits for landing as determined by the elevator position indicator (EPI) check. Correction in the form of changes in wing sweep and/or flap setting may be required, as well as fuel management techniques, depending on the particular situation. A discussion of center-of-gravity problems and some possible solutions are contained in this section under "Center-of-Gravity Considerations."

CENTER-OF-GRAVITY CONSIDERATIONS.

Aircraft center-of-gravity position limits are based on aircraft configurations and center of lift locations. The elevator position indicator (EPI) may be used for an in-flight check to determine whether or not the aircraft center-of-gravity is within limits. If an in-flight center-of-gravity problem occurs several things can be done to correct the situation. The aircraft can be made more stable by varying its center of lift position and/or its center-of-gravity position. The center of lift position may be changed by sweeping the wing and by varying the flap setting. Fuel management techniques are the primary means to alter the center-of-gravity position. An EPI check can be used to obtain an average elevator position corresponding to the center-of-gravity position for a given aircraft configuration. If elevator readings obtained in flight do not fall in the appropriate allowable elevator position ranges it means that the center-of-gravity limits for that particular aircraft configuration have been exceeded, and that corrective action must be taken.

AFT CENTER-OF-GRAVITY FOR LANDING.

If an aft center-of-gravity problem is indicated by an elevator position reading below the corrective minimum allowable setting, corrective action is required to move the center-of-gravity forward and/or move the center of lift aft. Increasing the fuselage tank fuel differential will move the center-of-gravity forward, while sweeping the wings aft shifts the center of lift aft. Jettison of external stores results in a slight forward movement of the center-of-gravity with an accompanying aft movement of the center of lift. With fuel remaining in the forward fuselage tank only, the center-of-gravity will move aft as fuel is consumed. Accurate determination of final approach configuration is critical since; (1) stabilizer effectiveness decreases as the aircraft is slowed, and (2) flap extension, especially the first 15°, moves the center of lift forward. Slat extension has very little effect on the center of lift. If a go-around is necessary, large or rapid power increases should be avoided to prevent the associated nose up pitching moment. With the pitch damper off, the aircraft becomes increasingly sensitive to longitudinal stick inputs as the center-of-gravity moves toward the aft limit. However, landings with the pitch damper inoperative with the center-of-gravity at the aft limit have been accomplished.

FORWARD CENTER-OF-GRAVITY FOR LANDING.

If a center-of-gravity forward limit is indicated by an elevator position above the maximum recommended setting, corrective action is required to move the center-of-gravity aft by decreasing the fuselage fuel tank differential, and/or move the center of lift forward by sweeping the wing forward. Even though the extension of flaps moves the center of lift forward, elevator effectiveness is reduced to slower approach speeds. For a forward center-of-gravity problem, the higher approach speeds associated with intermediate flap settings will help to insure adequate elevator effectiveness.

CENTER-OF-GRAVITY COMPUTATION.

While the wing sweep for landing chart in this section and the elevator position indications in this section and section V should provide center-of-gravity control guidance, occasions may arise for which the pilot may need to compute the actual center-of-gravity location. Figure 6-10 is provided for this purpose. The effect of weapons and fuel loadings on center-of-gravity is presented as a function of weight and moment index (moment is in pounds/100,000). The individual values obtained from this are added to the basic aircraft moment and then converted to percent MAC. The resulting center-of-gravity location can then be compared to the limits in sections V and VI.

Center of Gravity Computation

(Internal Fuel and Bay Stores)

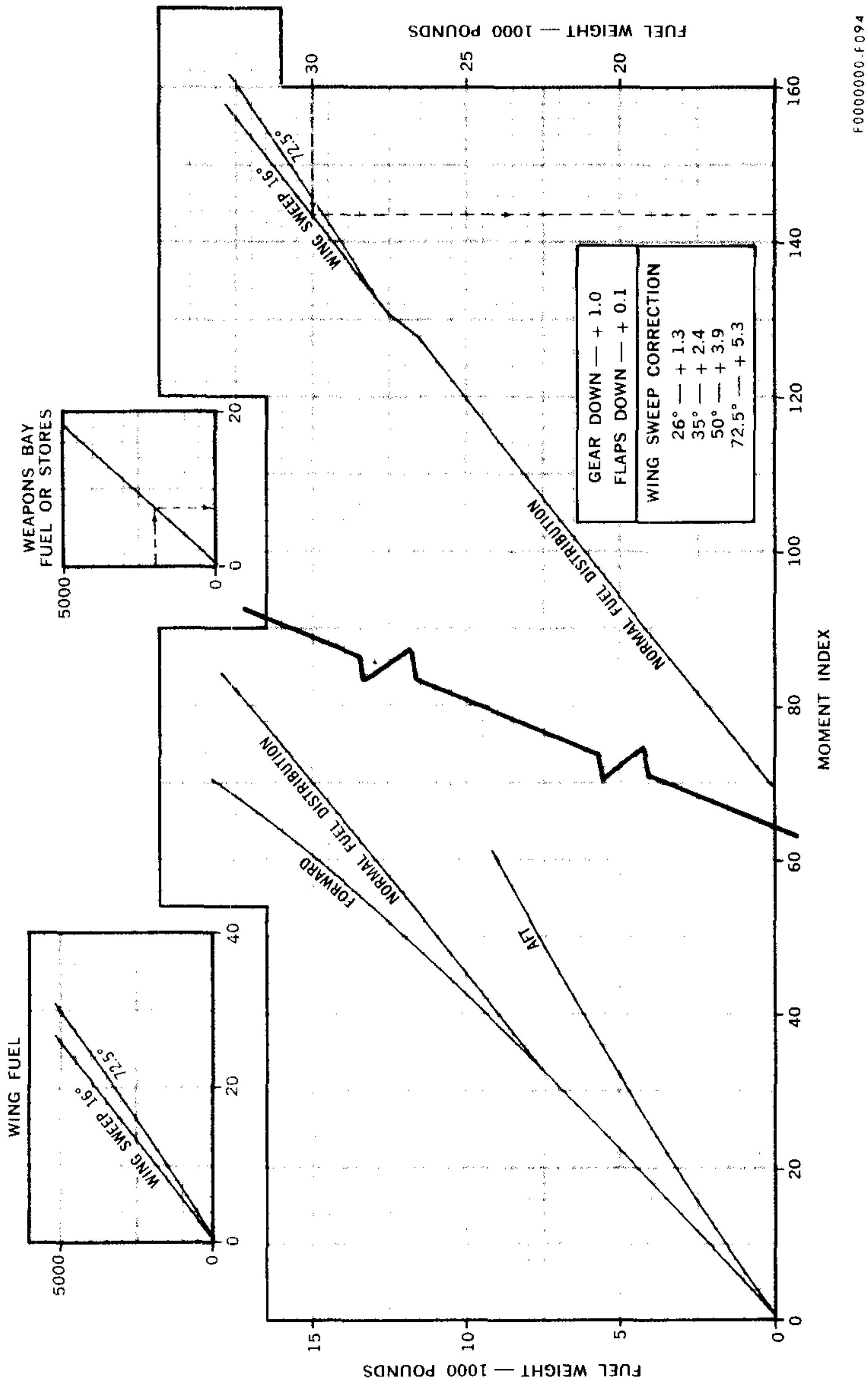

Figure 6-10. (Sheet 1)

Center of Gravity Computation

(External Stores)

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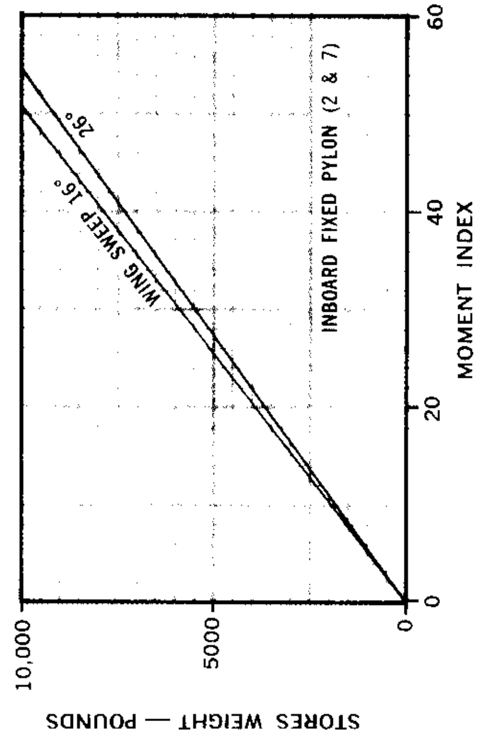

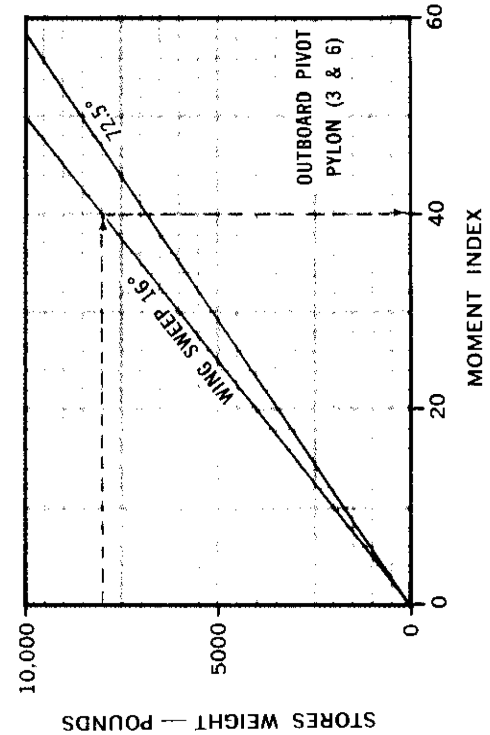

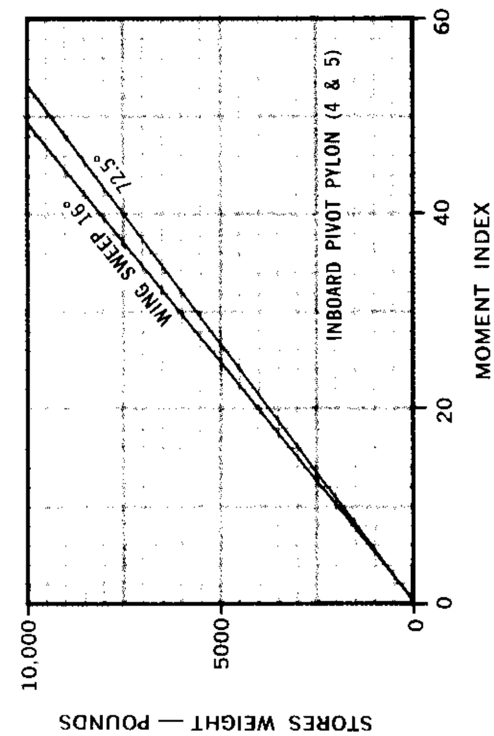

Figure 6-10. (Sheet 2)

Center of Gravity Computation

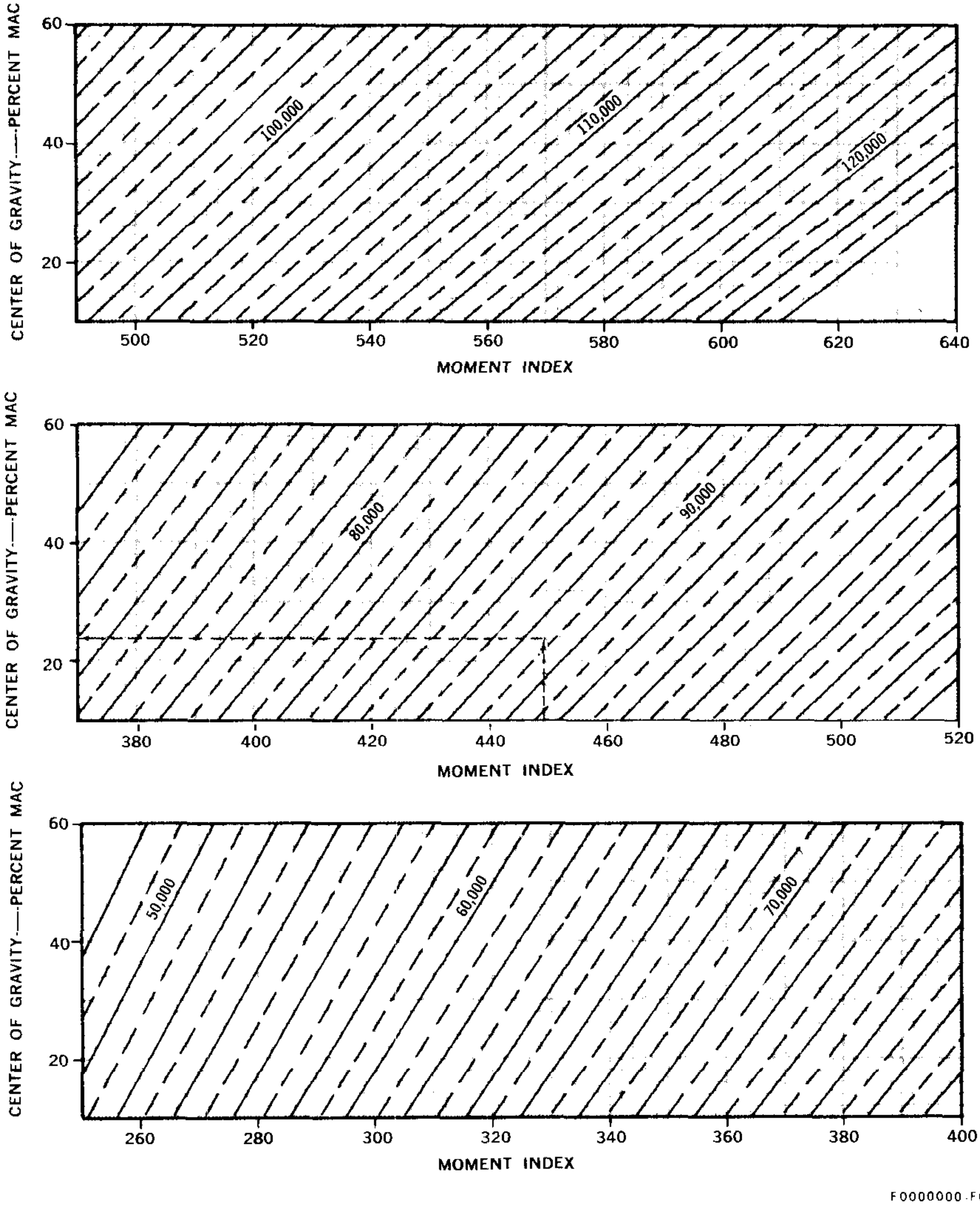

Figure 6-10. (Sheet 3)

Example:

Given: Basic aircraft weight and moment index. (Actual aircraft weight and moment should be used if available—if not available a weight of 48,813 pounds and a moment index of 256.4 may be used).

Fuel	30,000 pounds.
Weapons Load:	
Weapon bay	2,000 pounds.
Stations 3 & 6	8,000 pounds.
Wing Sweep	26 degrees.

Find: Center-of-gravity location in percent MAC to takeoff.

Solution: From figure 6-10 find moment index.

	Weight	Moment Index
Basic Aircraft	48,813 pounds.	256.4
Weapons Bay	2,000 pounds.	7.5
Stations 3 & 6	8,000 pounds.	40.0
Fuel	30,000 pounds.	143.5
Wing Sweep 26	—	1.3
Gear Down	—	1.0
Flaps Down	—	0.1
Total	88,813 pounds.	449.8

Enter figure 6-10 with the total weight and moment index and determine the MAC is 23.9 percent.

Note

Form 365F should not be computed using these charts due to the accumulation of tolerances involved.

ENGINE STALL CHARACTERISTICS.

Engine stalls are caused by aerodynamic disruption of the airflow in the engine compressor similar to the disruption in flow encountered during a wing stall. Engine stalls may be induced by engine or inlet control malfunction, excessive angle-of-attack or yaw causing poor inlet air distribution, or rapid throttle reversal (high power to low power and return). Engine stalls may be self clearing, may cause flameout, or may result in a fully developed steady state stall. In case of a self clearing stall, no immediate action is required. In some cases the engine will stall and immediately recover with the only evidence of a stall being a light to moderate "bang." In case the stall causes a flameout, the automatic restart circuit in the engine may furnish ignition and the engine may be recovered by moving the throttle to idle to gain a restart and then applying power. If this does not happen it will be necessary to depress the airstart button. The fully developed steady state stall requires recognition and corrective action to restore power and prevent damage to the engine from over temperature. An engine stall may be recognized by a pulsation felt through the airframe, an audible noise which may vary from a faint muffled thud to a very loud "bang," a loss of thrust indicated on the engine instruments, no EPR response to throttle movement, as a general rule a rise in turbine inlet temperature, a decrease in fuel flow and possible nozzle closing, if operating in afterburner.

ENGINE STALL RECOGNITION.

Fan stalls result in an audible "bang" with an almost immediate recovery to military power and in some cases to afterburner power (with the throttle in A/B). These stalls occur and recover too quickly to be detected by observing any engine instrument except nozzle position, to determine which engine stalled. The nozzle will end up in a closed position, if recovery is to the military power range, or will be transitioning from closed to open if it recovers to afterburner. Compressor stalls are noted by the audible "bang" and in most cases, at supersonic speeds, are preceded by a period of inlet rumble. The engine instruments react as follows during a compressor stall:

- EPR—quickly drops to 1.0.
- RPM—decreases at a moderate rate to below a normal idle speed and then is slowly unstable until stall recovery.
- TIT—flashes to a high TIT followed by an unstable decrease to some base level where it remains unstable until the engine recovers.
- Fuel flow—decreases at a moderate rate towards that required for the RPM and then is unstable until stall recovery.
- Nozzle position:
  (a) If in non-afterburning operation—no change.
  (b) If in afterburning operation—nozzle transition, recovery will be to non-afterburning operation if nozzle goes full closed.

The best indicator of a stalled engine is its TIT—it will be significantly and abnormally different from the unstalled engine. The peak-out TIT will depend on airspeed and altitude. For example, the peak-out TIT will be higher at mach 1.2/50,000 feet than at mach 2.0/50,000 feet or at mach 1.2/30,000 feet.

Note

Stalls have been experienced above 30,000 feet during deceleration from high mach numbers with the speed brake extended. These stalls do not have the characteristic bang and the pilot may not be aware of the stalled condition. The stall will become apparent when power is advanced and the engine does not respond.

If engine stall is encountered, refer to "Compressor Stall", Section III.

This is the last page of Section VI.

SECTION VII

ALL WEATHER OPERATION

TABLE OF CONTENTS.

Note

In general, this section consists of procedures and information which differ from, or are supplementary to, the normal operating procedures in Section II. In some cases, however, repetition has been necessary for emphasis, clarity, or continuity of thought.

INSTRUMENT FLIGHT PROCEDURES

This aircraft is designed to perform operational missions in all extremes of weather. On instrument flights, delays in departure and descent, and low climb rates to altitude are often required in high density control areas. These factors may increase fuel consumption, reduce flight endurance and dictate that all flight under instrument conditions be carefully planned and that due consideration be given to the additional time and fuel which may be required.

BEFORE TAKEOFF.

1. Line up visually with center line of runway.
2. Instrument system coupler mode selector knob —MAN HDG. (As required).
3. HSI heading set knob—Set runway heading.
4. Attitude indicator—Adjust pitch trim knob to index.

INSTRUMENT TAKEOFF.

An instrument takeoff is accomplished using a combination of visual and instrument references. Procedures are the same as for a normal takeoff. After the brakes are released, use visual references to maintain alignment. As the takeoff progresses, the pilot's cross-check should transition from outside references to the aircraft instruments. Rate of change is dependent upon how rapidly outside references deteriorate. It is very important that the transition to instrument references be complete before losing outside references. At rotation speed, smoothly rotate the aircraft to increase indicated attitude to 10 degrees above indicated ground static attitude. Crosscheck the vertical velocity indicator and altimeter to insure a positive rate of climb before retracting the gear and flaps/slats.

INSTRUMENT CLIMB.

After liftoff, maintain the 10 degree pitch attitude used for takeoff to obtain a positive increase in both altitude and airspeed and complete desired configuration changes as for a normal takeoff. After establishing climb configuration, control aircraft attitude to maintain a positive increase in airspeed and altitude until attaining desired climb speed. The climb schedule recommended in Appendix I is suitable for instrument flight. A crosscheck of all instruments, particularly the turn indicator, is extremely important during initial climb to verify reliability of all instruments.

INSTRUMENT CRUISING FLIGHT.

Thrust settings and configuration for optimum cruise schedule recommended in Appendix I are satisfactory while using standard instrument techniques. Maximum bank angle of 30 degrees is normally used.

HOLDING.

Holding should be accomplished at 300 KIAS. Maximum bank angle of 30 degrees is normally used.

JET PENETRATION.

Prior to beginning penetration, check the weather and availability of radar or ILS. If ceiling or visibility is below minimum, make the decision to proceed to an alternate while still at altitude. For maximum range, an idle power descent at 250 KIAS with 26 degree wing sweep and speed brake retracted is recommended. For minimum time in descent, 350 KIAS with 26 degree wing sweep and speed brake extended is recommended. A normal penetration, either TACAN or Enroute, is accomplished at 300 KIAS with 26 degree wing sweep, speed brake extended and approximately 80% power. Upon arrival at the initial approach fix (IAF), retard throttles to approximately 80%, extend speed brake, lower nose to maintain 300 KIAS, and accomplish the penetration as required. One thousand feet above level-off altitude, retract speed brake, as required, and adjust power as required to maintain desired altitude and an airspeed compatible with aircraft configuration and gross weight (250 to 300 KIAS). Do not exceed 10 degrees angle of attack during maneuvering flight or aircraft configuration changes. Do not decelerate below 240 KIAS prior to full extension of slats.

INSTRUMENT APPROACHES.

WARNING

- High angles-of-attack can occur rapidly with power, bank, and aircraft configuration changes. Therefore, throughout all instrument traffic pattern maneuvering, the angle-of-attack indicator and indexers should be closely monitored and included in the normal instrument crosscheck. Ten degrees angle-of-attack should not be exceeded during pattern maneuvering and aircraft configuration changes.
- For normal operation, slats should be extended by a minimum airspeed of 240 KIAS. Do not roll or execute abrupt maneuvers with slats only extended.

Note

- Maintain an airspeed compatible with aircraft configuration and gross weight (250 to 300 KIAS). Do not exceed 10 degrees angle of attack during maneuvering flight or aircraft configuration changes. Do not decelerate below 240 KIAS prior to full extension of slats. If it becomes necessary to reduce speed for pattern spacing, extend gear, slats/flaps, and maintain a minimum of computed approach speed plus 20 knots (160 KIAS minimum) until rolled out on final.
- Turbulence, gusty winds or other conditions may exist which may induce variations in angle-of-attack or airspeed or will cause excessive sink rates to develop on final approach. The pilot may decrease angle-of-attack to 8 degrees or increase final approach speed 10 knots in such cases to improve aircraft handling characteristics. To avoid undesirable touch down characteristics, this additional airspeed should be dissipated so that an "on-speed" indication exists prior to initiation of flare.

TACAN APPROACH.

A typical Tacan Penetration/Approach is illustrated on figure 7-1. Complete the "Before Landing"/"Transition" Checklist prior to the final approach fix. Maintain an airspeed compatible with aircraft configuration and gross weight (250 to 300 KIAS). Do not exceed 10 degrees angle of attack during maneuvering flight or aircraft configuration changes. Do not decelerate below 240 KIAS prior to full extension of slats. Reduce airspeed to computed approach speed plus 20 knots minimum (160 KIAS minimum) until aircraft is rolled out on the final approach course. Prior to final approach fix, establish desired angle of attack/airspeed. Do not descend below minimum descent altitude (MDA) unless runway is in sight.

PAR/ASR.

Radar approaches should be flown at 26 degree wing sweep or less (as required by CG for landing) and clean configuration until accomplishing the "Before Landing" checks. Maintain an airspeed compatible with aircraft configuration and gross weight (250 to 300 KIAS). Do not exceed 10 degrees angle of attack during maneuvering flight or aircraft configuration changes. Do not decelerate below 240 KIAS prior to full extension of slats. After gear and slat/flap extension, reduce airspeed to computed approach speed plus 20 knots minimum (160 KIAS minimum). Maintain this airspeed until completion of turn onto final approach. After rolling out on final, establish desired angle of attack/airspeed. At the decision height (DH), on a precision approach, make the decision to land or perform

Tacan Penetration/Approach (Typical)

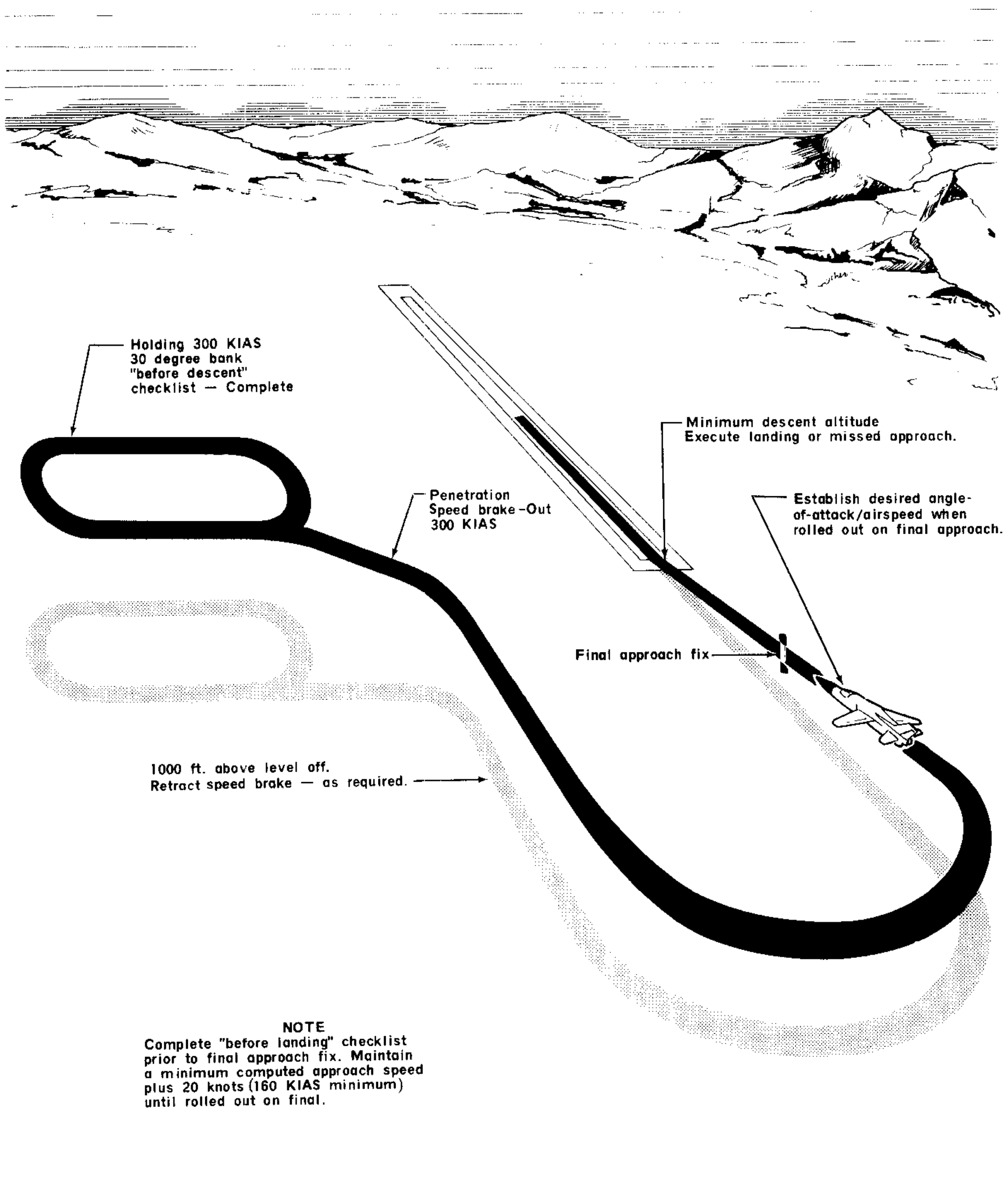

Figure 7-1.

Radar/ILS/AILA Approach (Typical)

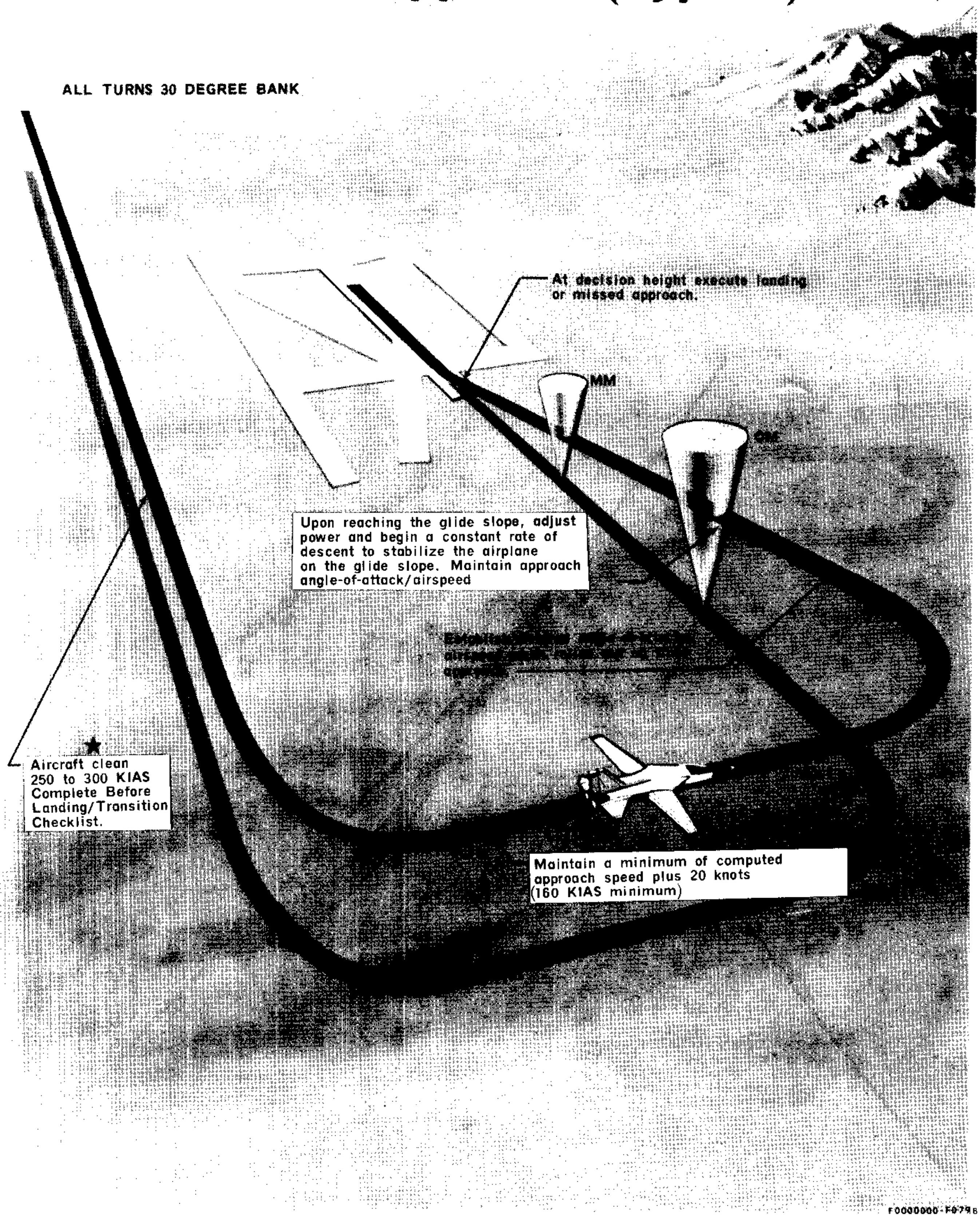

Figure 7-2.

the missed approach procedure. On a surveillance approach, do not descend below minimum descent altitude (MDA) unless runway is in sight. The radar altimeter and radar altitude low warning lamp may be used to monitor aircraft altitude in relation to DH/MDA, however, the altimeter is the primary instrument reference for determining arrival at DH/MDA.

ILS/AILA.

CAUTION

AILA should only be attempted during daylight VFR conditions.

Aircraft configuration and airspeeds for ILS/AILA approaches are the same as for PAR/ASR approaches. A typical Radar ILS/AILA Approach is illustrated on figure 7-2. If the ILS/AILA final approach course is to be intercepted directly from the penetration, maintain computed approach speed plus 20 knots minimum (160 KIAS minimum) after landing gear and slat/flap extension until aircraft is rolled out on the final approach course, then establish desired angle-of-attack/airspeed. Use the command steering bars on the ADI and ODS to aid in intercepting and maintaining the localizer course and glide slope. It is very important to remember that although the command steering bars are an aid in flying the final approach, the course deviation and glide slope indicators are the primary reference for determining aircraft position in relation to the final approach course. While accomplishing an ILS/AILA, the radar altimeter low warning lamp will come on and the pitch steering bar will stow full up when the aircraft absolute altitude passes through the value set on the minimum altitude index pointer. Procedures at DH/MDA are the same as for PAR/ASR approaches.

ENROUTE/STRAIGHT-IN APPROACHES.

The turbojet enroute descent requires some special consideration. The descent must be initiated early enough to permit aircraft configuration and checklist completion prior to the final approach fix or glide slope interception. Special attention must be given to aircraft position in relation to the final approach course by use of available navaids and the bomb-nav system. The "Before Landing" Checklist will be completed and desired angle-of-attack/airspeed established prior to the final approach fix or glide slope interception. Maintain an airspeed compatible with aircraft configuration and gross weight (250 to 300 KIAS). Do not exceed 10 degrees angle-of-attack during maneuvering flight conditions or aircraft configuration changes. Do not decelerate below 240 KIAS prior to full extension of slats. After landing configuration is established, maintain a minimum of computed approach speed plus 20 knots (160 KIAS minimum) until on the final approach course, then establish desired angle of attack/airspeed.

MISSED APPROACH.

If a missed approach is required, smoothly advance power as necessary to insure an increase in airspeed and altitude. When both are increasing, retract gear and flaps/slats in accordance with normal takeoff procedures. Accomplish "After Takeoff" checks if proceeding to an alternate or "Transition" checks if another approach is being planned to the same destination.

ICE AND RAIN

The aircraft is equipped with engine anti-icing, pitot heat, and windshield rain removal provisions. Refer to "Anti-Icing and Defogging Systems," Section I. There are no provisions for surface anti-icing. Flight through areas of sustained heavy icing is not recommended. The performance capabilities of the airplane should be utilized to avoid extreme icing conditions. When moderate to heavy icing is encountered, a change in altitude, course, or airspeed should be made to prevent ice accumulation on the wings and empennage. Engine anti-icing capabilities should be utilized whenever icing conditions are anticipated.

Substantial ice buildups can necessitate increased power setting for maintaining airspeed and could cause distortions in the shape of air foil surfaces, thus affecting the lift and handling characteristics of the aircraft. Either of these conditions tends to reduce total range. Flight can be safely accomplished during light to moderate icing by using normal flight procedures. Rain has little or no appreciable effect on the flight characteristics.

OPERATION IN RAIN OR ICING CONDITIONS.

Icing is possible under the following conditions:
Ground operation.

- In visible moisture—Temperature between 35°F and −10°F.
- In clear air—Relative humidity above 70 percent and dew point temperature 25°F to 35°F.

Inflight operation.

- In visible moisture—Total temperature of +5°C or below.
- In clear air—No limitations related to icing.

Aircraft with an operational anti-icing system are cleared for flight in limited icing conditions as follows:

Note

For definitions of light, moderate, and heavy icing conditions, refer to Air Weather Service Manual 105-39.

a. Light icing conditions: Aircraft are cleared for all normal service use at all altitudes. The rate of ice accretion in light icing conditions is ordinarily insufficient to make diversionary action necessary. Takeoffs, descents, penetrations, low approaches and landings, when icing conditions exist, should be planned to minimize the occurrence of ice ingestion and engine stalls.

b. Moderate icing conditions: Aircraft operation in moderate icing conditions may be tolerated for short periods of time but some type of evasive action (changing altitude, course, or airspeed) will have to be undertaken to exit the icing condition when ice is observed accumulating on the aircraft structure. Continuous flight in moderate icing conditions during takeoff, approach or landing should not exceed 5 minutes duration at any airspeed. Cruising flight in moderate icing conditions may be tolerated for perhaps 5 minutes at airspeeds less than 250 KIAS, and for longer periods at higher airspeeds as long as no ice is observed accumulating on the aircraft.

c. The following icing conditions should be avoided:

- Heavy icing conditions.
- Icing conditions associated with thunderstorms at airspeeds which produce total temperatures from +5 C to —15°C.

GROUND OPERATION.

Operate the aircraft and systems as indicated in the "Cold Weather Procedures," in this section. Rain removal should be used when needed to improve visibility.

CAUTION

Painted areas on runways, taxiways, and ramps are significantly more slippery than non-painted areas. When painted areas are wet, the condition may deteriorate to the extent that the coefficient of friction is negligible. In addition, painted areas sometimes serve as condensation surfaces and it is possible to have wet, frosty, or even icy conditions on these areas when the overall weather condition is dry. When conditions of snow or ice exist, the approach end of the runway is usually more slippery than other areas because of the melting and refreezing of the ice and snow at this point.

TAKEOFF AND INITIAL CLIMB.

Accomplish takeoff in the normal manner. Apply brakes and advance throttles for takeoff. If aircraft starts to slide on ice or snow before full power is reached, release brakes and begin takeoff run. Continue advancing power during takeoff run and check engine instruments for proper operation. Refusal speed will be considerably lower and the emergency stopping distance greater on wet or icy runways.

WARNING

Engine stalls may be caused by water ingestion if takeoff is attempted with accumulated water on the runway.

CRUISE.

Operate the aircraft as necessary to avoid icing conditions whenever possible. When ice is encountered, pitot heat and engine anti-icing should be used. Do not operate in rain, sleet, or hail longer than absolutely necessary. If it becomes necessary to fly in these conditions, constantly check the aircraft leading edges, including radome, for indications of peeling or other structural deterioration of the aircraft surfaces. In the event deterioration of surfaces is observed, maintain airspeed as low as practicable and land at the nearest suitable airfield as soon as possible. If heavy precipitation conditions of the above type are encountered at any speed or light to moderate conditions exist at high airspeeds, an entry must be made in Form 781.

CAUTION

To minimize impact damage from rain or sleet, do not exceed 450 KTAS.

TURBULENCE AND THUNDERSTORMS

WARNING

Flight through thunderstorm activity or known severe turbulence is not recommended and should be avoided if at all possible. Careful judgment must be exercised by the pilot in determining capability to safely enter or circumnavigate areas of such weather activity. The appropriate corrective action to be taken if moderate or greater turbulence is forecast will be preplanned with assistance of the weather forecaster during the weather briefing.

The use of attack radar, air-to-air mode, provides an excellent means of navigating between or around storm cells. If circumstances should force the flight into a zone of severe turbulence or heavy precipitation, establish throttle setting and pitch attitude. An airspeed of 275-300 KIAS and a 26 degree wing sweep are recommended for thunderstorm penetration and for operation in areas of known severe turbulence or heavy precipitation. To reduce vision deterioration from lightning, the high intensity white cockpit lighting should be adjusted to the required level prior to penetration. If flight into an area of heavy precipitation cannot be avoided, the tolerance of the engines to water ingestion can be increased by activating the bleed air systems for the engine/inlet anti-icing system and the windshield rain removal system. Prepare the engines for penetration of heavy precipitation as follows:

1. Engine/inlet anti-icing switch—MAN.
2. Windshield selector switch—BOTH.
3. Rain removal switch—RAIN REMOVE.

Note

- Optimum engine tolerance to water ingestion will be assured by an EPR setting between 1.8 and 1.5. If unusually heavy precipitation is encountered, the airstart button may be held depressed to provide continuous ignition for as long as is considered necessary. After the button is released, ignition will continue to be provided for approximately 55 seconds. If an engine stall or flameout occurs, use the "Engine Stall" and/or "Airstart" procedures, Section III.
- When using terrain following radar, the back scatter from drizzle or rain and other forms of precipitation will often be visible on the scope. It should be quite apparent to the operator that if the precipitation is so heavy that he cannot determine visually where the terrain ends and the precipitation begins, the automatic signal detection circuitry will also be incapable of this discrimination and a climb command will result.
- Turbulence associated with penetration of thunderstorms can result in excessive high angles-of-attack with resultant marginal engine performance.

NIGHT FLYING

Night flight necessitates a high degree of instrument proficiency and more dependence on flight instruments than would be expected for normal day VFR operation. Otherwise, techniques used in night flying do not differ appreciably from those used in daylight operation. Cockpit lighting has been designed to enhance night flying capability.

WARNING

The anti-collision lights should be turned OFF during flight through actual instrument conditions to avoid spatial dis-orientation resulting from the rotating reflections on the clouds. The navigation lights may be set to flash unless this becomes distracting in clouds.

COLD WEATHER PROCEDURES

Most cold weather operating difficulties are encountered on the ground. The following instructions are to be used in conjunction with the normal procedures given in Section II when cold weather operation is necessary.

BEFORE ENTERING AIRCRAFT.

WARNING

- All accumulated ice and snow must be removed from the aircraft before flight is attempted. For complete ice and/or snow removal procedures, refer to T.O. 1F-111(B) A-2-1. Takeoff distance and climb out performance can be adversely affected by ice and snow accumulations. The degree of roughness and distribution of these accumulations can vary stall speeds and alter flight characteristics to a degree hazardous to safe flight.
- Ensure that water does not accumulate on control surfaces or other critical areas where refreezing may cause damage or binding.
- After ground cold soak at minus 50°F heat the rocket motor compartment with warm air, between 80° to 120°F for 30 minutes, prior to takeoff.

CAUTION

- To avoid damage to aircraft surfaces, do not permit ice to be chipped or scraped away.
- Ensure that engines are free to rotate and that engine lower section moisture is thawed-out per T.O. 1F-111(B)A-2-1.

Remove all protective covers and duct plugs; check to see that all surfaces, ducts, struts, drains and vents are free of snow, ice and frost. Ice and encrusted snow may be removed by using de-icing fluid or by direct air flow from a portable ground heater. Inspect the aircraft carefully for fuel and hydraulic leaks caused by the contraction of fittings or by shrinkage of packings. Inspect areas behind the aircraft to ensure that water or snow will not be blown onto personnel and equipment during engine start.

STARTING ENGINES.

Use normal procedures for starting engines. The throttles may be advanced to allowable power settings as long as engine instruments register within the engine operating limits. Refer to "Engine Operating Limits," Section V.

CAUTION

To prevent aircraft sliding on icy surfaces during engine start it may be necessary to utilize an external power source for starting both engines.

Note

Unless fast warmup of the hydraulic systems is required, no hydraulic actuator movement should be attempted for the first few minutes of engine operation until the hydraulic fluid has warmed up to zero degrees Fahrenheit or above (monitored at hydraulic reservoirs).

Note

After T.O. 1F-111-963, if bomb nav system alignment is performed at ambient temperature of zero degrees Fahrenheit or colder, system error rate in unaided inertial mode may be degraded by a factor of two. After T.O. 1F-111-877, the bomb nav system error rate in unaided inertial mode is no longer degraded.

BEFORE TAXIING.

Check flying controls, flaps and slats for proper operation. Cycle flight controls to circulate warm fluid throughout the systems and check control reaction and operation. Prior to taxiing, depress and release brake pedals to insure freedom of operation in both directions.

TAXIING.

WARNING

Nose wheel steering may not be completely effective when taxiing on ice or hard packed snow. A combination of nose wheel steering and braking is recommended. Exercise care and taxi at reduced speed while operating on these surfaces. Increase the normal interval between aircraft to insure safe stopping distance and to prevent icing of aircraft surfaces by melted snow and ice in the jet blast of preceding aircraft. Insure that all instruments have warmed sufficiently to insure operation. Check for sluggish instruments during taxiing.

CAUTION

Painted areas on runways, taxiways and ramps are significantly more slippery than unpainted areas, particularly when wet. In addition, painted areas sometimes serve as condensation surfaces and it is possible to have wet, frosty or even icy conditions on those areas when the overall weather condition is dry.

TAKEOFF.

Insure that takeoff data accounts for reduced braking capability due to ice and snow on runway in event of an abort. Make normal takeoff. Apply brakes and advance throttles for takeoff. If aircraft starts to slide on ice or snow before full power is reached, release brakes and begin takeoff run. Continue advancing power during takeoff run and check engine instruments for proper operation. Care should be exercised to avoid exceeding climb schedule speeds due to additional thrust available at low temperatures.

AFTER TAKEOFF.

Follow normal procedures.

DESCENT.

Follow normal procedures.

LANDING.

After the aircraft is in the landing configuration, depress and release the brake pedals to insure freedom of operation in both directions.

Note

Brake applications available will be limited if a hydraulic system has failed and emergency isolation has occurred. Refer to "Landing With Primary or Utility Hydraulic System Failure," Section III.

ENGINE SHUTDOWN.

Follow normal procedures.

BEFORE LEAVING THE AIRCRAFT.

Leave the canopy partly open; this will allow circulation within the cockpit to reduce windshield and canopy frosting.

HOT WEATHER AND DESERT OPERATION

Hot weather and desert operation requires that added precautions be taken against damage from dust, sand, and high temperatures. Particular attention should be given to those components and systems (engine, fuel, oil, hydraulic, pitot-static, etc.) which are susceptible to contamination, malfunction, or damage from sand and dust. All the filters on the aircraft should be checked frequently. Components containing plastic or rubber parts should be protected as much as possible from blowing sand and extreme temperatures. During conditions of blowing sand and dust, the canopies should be closed and sealed and all protective covers installed when the aircraft is not in use.

CAUTION

Do not attempt takeoff or engine operation in a sand storm or dust storm if avoidable.

EXTERIOR INSPECTION.

Inspect the exposed areas of the shock strut and actuator pistons on the landing gear and have them cleaned as required. Check engine inlet ducts for sand accumulation. Check tires for signs of blistering, and check for overinflation of tires and struts due to high ambient temperatures. Check for fuel or hydraulic leakage due to thermal expansion of sealing materials. Inspect the area aft of the aircraft to make sure that engine exhaust will not cause sand or dust to be blown onto personnel or equipment when engines are started.

INTERIOR INSPECTION.

Inspect the crew compartments for excessive dust accumulation.

ENGINE START.

Follow normal procedures.

BEFORE TAXIING.

Ground checks should be accomplished as expeditiously as possible.

TAXIING.

Follow normal procedures.

TAKEOFF.

Allow for longer takeoff distances in hot weather. Refer to Appendix I for takeoff data.

CAUTION

It is imperative that takeoff not be made at lower than recommended speeds. When outside air temperature is high, do not rotate too soon, as more than usual takeoff distance will be required to obtain takeoff speed.

APPROACH AND LANDING.

Maintain recommended approach and landing speeds as shown in Appendix I. Allow for longer landing rolls resulting from increased true airspeeds.

CAUTION

High surface temperature conditions often result in unexpected gusts and wind shears near the ground.

ENGINE SHUTDOWN.

Follow normal procedures.

CAUTION

To minimize canopy and windshield damage, consideration should be given to parking the aircraft tail into the wind.

BEFORE LEAVING THE AIRCRAFT.

Leave the canopy open, if the aircraft is to be exposed to direct sunlight at ambient temperatures above 100 degrees Fahrenheit. This will prevent excessive heat build-up within the cockpit. Close the canopy in the evening and any time there is a possibility of blowing sand or dust.

This is the last page of Section VII.

Appendix I
PERFORMANCE DATA

Performance Data is contained in Appendix I of Supplement T.O. 1F-111(B)A-1-1.

ALPHABETICAL INDEX

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